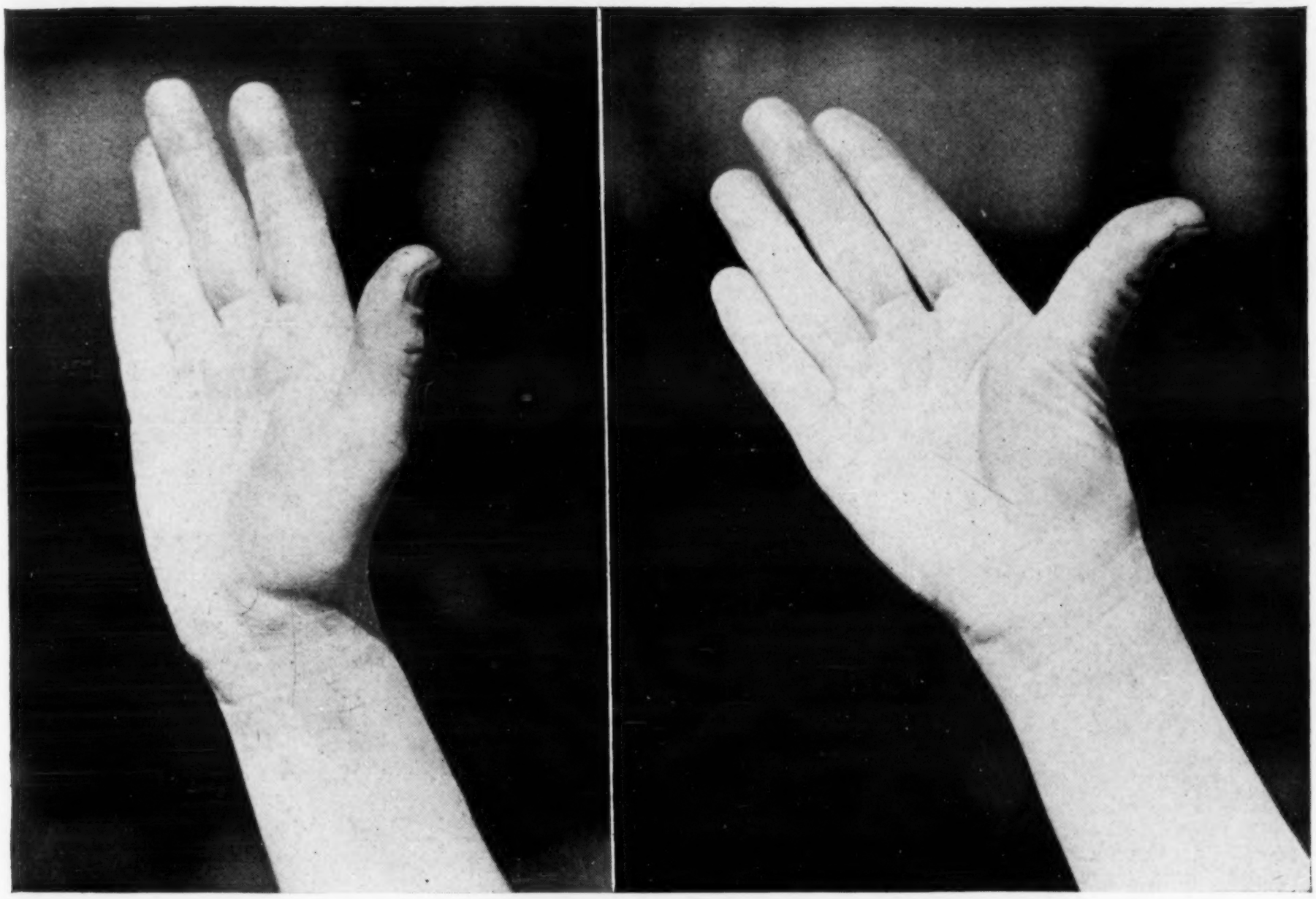
RIODICAL ROOM
NERAL LIBRARY
IV. OF MICH.

NOV 18 1932

The Journal of HEREDITY



DOUBLE JOINTED THUMBS INHERITED

(SEE PAGE 425)

Echoes of the Eugenics Congress

The Self-Pruning Tomato

Squash-Gourd Hybrids

A Headless Sheep

A Double-Flowered Apricot

Inheritance of Hair Whorls

Theories of Evolution

Zebra Maize

Problems of Population

VOLUME 23 OCTOBER, 1932 NUMBER 10

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President — Vice-President, W. E. CASTLE — Secretary, C. E. LEIGHTY

Treasurer, MRS G. W. SINCELL

Legal Advisors, PEELLE, OGILBY and LESH

EDITORIAL BOARD

Managing Editor: ROBERT C. COOK

M. DEMEREC — R. R. GRAVES — L. C. DUNN

H. J. MULLER — GEORGE M. DARROW — PAUL POPENOE

Members of the Council are ex-officio members of the Editorial Board

COUNCIL

W. E. CASTLE, Professor of Zoology, Harvard University, and Research Associate of the Carnegie Institution of Washington.

LEON J. COLE, Professor of Genetics, University of Wisconsin.

G. N. COLLINS, Botanist, U. S. Department of Agriculture, Washington, D. C.

O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture.

DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.

HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigations, U. S. Department of Agriculture.

SAMUEL J. HOLMES, Professor of Zoology, University of California, Berkeley, California.

C. E. LEIGHTY, Agronomist in Charge of Eastern Wheat Investigations, U. S. Department of Agriculture.

VERNON KELLOGG, Permanent Secretary, National Research Council, Washington, D. C.

J. H. KEMPTON, Bureau of Plant Industry, U. S Department of Agriculture.

E. W. SHEETS, Chief of Animal Husbandry Division, U. S. Department of Agriculture.

SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.

E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.

E. A. BESSEY, Professor of Botany, Michigan State College, East Lansing, Michigan.

A. F. BLAKESLEE, Plant Genetist, Carnegie Institution, Cold Spring Harbor, New York.

J. K. BREITENBECHER, McGill University, Montreal, Canada.

W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.

C. B. DAVENPORT, Director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.

J. A. DETLEFSEN, Professor of Genetics, Wistar Institute, Philadelphia, Pennsylvania.

RUSSELL W. DUCK, Professor of Animal Husbandry, Syracuse University, Syracuse, New York.

E. M. EAST, Professor of Plant Genetics, Bussey Inst. of Applied Biology, Boston, Mass.

R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.

C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.

C. M. GOETHE, Sacramento, California.

HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.

H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.

D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

M. A. JULL, Senior Poultry Husbandman, U. S. Department of Agriculture, Washington, D. C.

F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana.

C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.

H. H. NEWMAN, Professor of Zoology, University of Chicago, Chicago, Ill.

T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.

JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhatten, Kansas.

MRS. CHARLES C. RUMSEY, Wheatly Hills, Westbury, Long Island.

JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.

A. D. SHAMEL, Physiologist, U. S. Department of Agriculture, Riverside, California.

GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.

EDMUND W. SINNOTT, Professor of Zoology, Barnard College, Columbia University, New York City. (Representative of A. G. A. on Council of Amer. Assoc. for the Advancement of Science.)

W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.

CHARLES R. STOCKARD, Professor of Anatomy. Cornell University, New York City.

A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.

W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.

LOU D. SWEET, Seedsman, Denver, Colorado.

W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.

H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.

H. J. WEBBER, Prof. Subtropical Hort., Citrus Experiment Station, Riverside, California.

E. N. WENTWORTH, Armour's Bureau of Agrl Research and Economics, Chicago, Illinois.

P. W. WHITING, Department of Biology, University of Pittsburgh, Pittsburgh, Pa.

The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 306, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 1918-32 Harford Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918.

Contents copyrighted 1932 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office.

$3.50 a Year, 35c the Copy. Prices of back numbers on application.

The

Journal of Heredity

Vol. XXIII OCTOBER, 1932 No. 10

CONTENTS

ECHOES OF THE EUGENICS CONGRESS..... 385

INHERITED CHARACTERS IN THE TOMATO
By John W. MacArthur..... 395

INHERITANCE OF WHORLS IN THE HAIR OF SWINE
By Julius E. Nordby..... 397

THREE VIEWS OF EVOLUTION..... 405

DOUBLE FLOWERS AND MULTIPLE FRUITS OF THE JAPANESE APRICOT
By Clayton O. Smith..... 411

HERITABLE CHARACTERS IN MAIZE
By H. K. Hayes..... 415

A HEADLESS SHEEP
By Nathan Fasten..... 421

A COLOR-MOSAIC IN THE MOUSE
By John J. Bittner..... 421

INHERITANCE OF DOUBLEJOINTEDNESS IN THE THUMB
By Leon F. Whitney..... 425

A FERTILE GOURD-PUMPKIN HYBRID
By Thomas W. Whitaker..... 427

Brief Reviews and Notes

BREEDING KARAKUL SHEEP..... 396
SCIENCE INTERPRETED 410
BOOKS RECEIVED 414
SHULL'S HEREDITY REVISED..... 423
PROBLEMS OF POPULATION..... 424
SEX-LINKED FACTORS GOVERNING MILK PRODUCTION..... 430

McGraw-Hill Publications in the Agricultural and Botanical Sciences

PRINCIPLES OF GENETICS

A Textbook, with Problems

By **Edmund W. Sinnott**, *Professor of Botany, Barnard College, Columbia University, and* **L. C. Dunn**, *Professor of Zoology, Columbia University.*

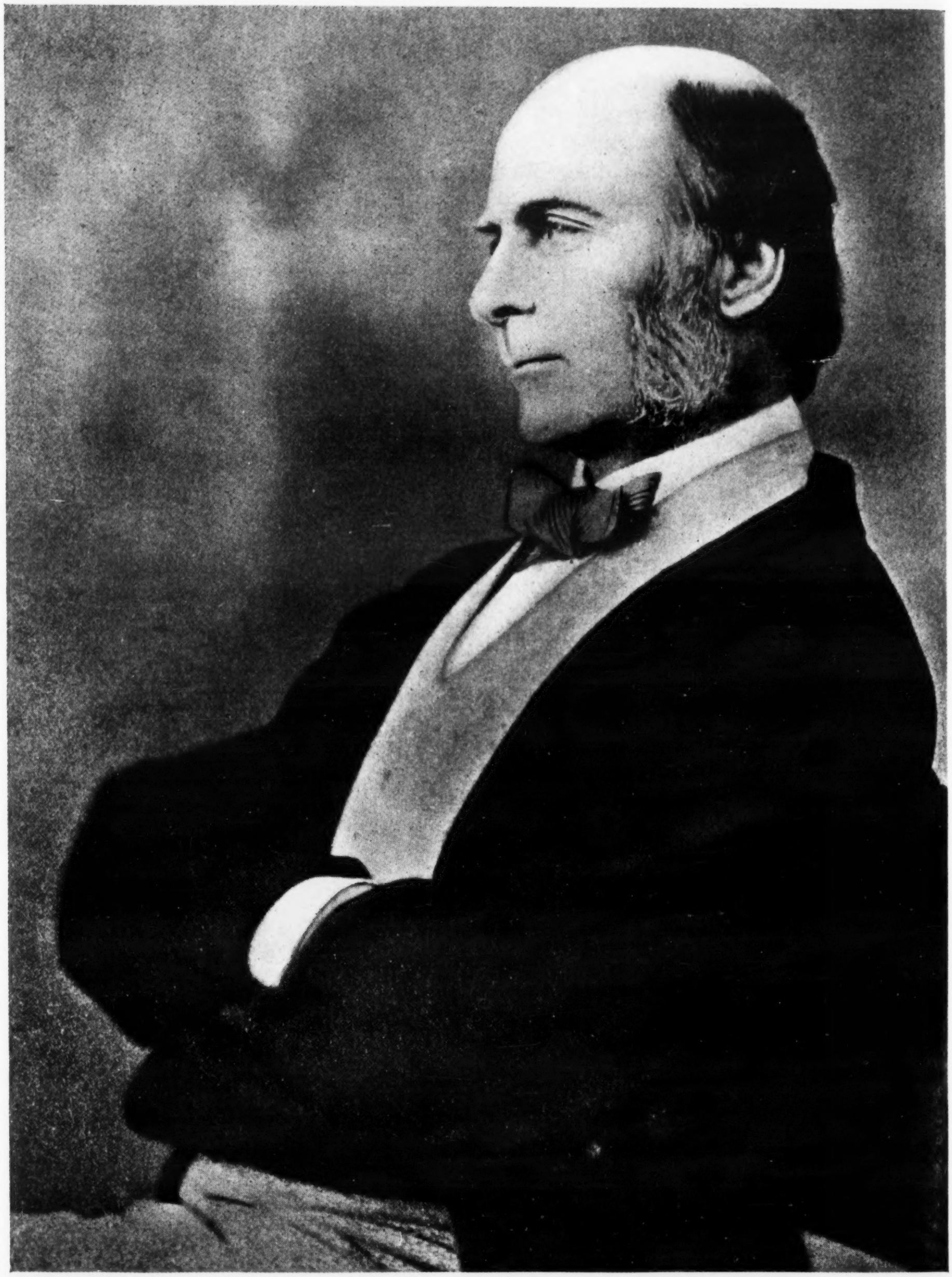
Second Edition, 441 pages, 6 x 9, illustrated. $3.50.

THIS standard text has now been brought completely up to date in a second edition. The revision incorporates those results of recent investigations which have led to important new ideas. Thorough treatment has been given to such subjects as the recent extensive analysis of chromosome changes; the discovery of segmental interchange between chromosomes; the cytological demonstration of crossing over; the mapping of genes in chromosomes by cytological methods; and the extension of the balance theory of sex and the establishment of the idea of balance in other fields. Two new chapters have been added. One deals with the important contributions of genetics to evolutionary theory; the other discusses the relation between genetics and the problems of development. The new edition, like the former, is exceptionally well equipped with problems, which have been extended to cover the entire field.

Send for a copy on approval

McGRAW-HILL BOOK COMPANY, Inc.

330 West 42nd Street **New York**



FRANCIS GALTON
1822-1911

Galton made fundamental contributions to many branches of science. The founding of the Eugenics movement is perhaps his greatest achievement. Eugenics he defined, in his will, as "the agencies under social control that may improve or impair the racial faculties of future generations physically and mentally."

ECHOES OF THE EUGENICS CONGRESS

The Trend of Eugenic Thought in 1932 as Reflected in the Papers Presented at the Third International Eugenics Congress

THE following paragraphs have been excerpted from the abstracts of papers presented at the Third International Congress of Eugenics, and from other sources. These excerpts by no means give an altogether complete summary of the subject matter of the Congress. Neither do they give a panorama-in-outline of the entire program, for two important reasons: (1) some of the abstracts did not lend themselves to excerpting and a few were omitted; (2) some of the papers presented were not included in the abstracts. These various views from many angles do, however, give something of a birds-eye-view of Eugenic thought in 1932.

WE are compelled to recognize that medical science, in its humanitarian purpose, preserves in many instances individuals who under the normal biological process of natural selection would be eliminated and cease to be a source of racial weakness. Medical science however need not relax its efforts to cure disease provided that it also seeks effective means of improving the general physical quality and resistance of the race. But unless a race by its own folly took some other short cut to its doom, the gradual lowering of its physical qualities and resistance would seem to be almost the greatest menace to its survival.

If medical science does not address itself equally to sustaining and building up racial qualities and racial vitality and resistance, as well as to individual palliation and relief, it promises to injure rather than improve the racial prospect for survival.

C. G. CAMPBELL.

President, Eugenics Research Association.

THE tendency to self-elimination of particular families may be still further augmented by the small family system if human groups react as do mouse colonies, where it has been found that improved conditions of living increase the incidence of latent defects, such as anaemia and malformations, and consequently cut down the percentage of effective offspring. In any event, the small human family probably provides a less rigorous and stimulating mental and physical discipline than does the large family.

On the other hand, while it may be expected that at the beginning, reduction in the number of offspring will automatically result in the chance elimination of many families from the upper ranks, the same laws of chance will serve temporarily to sustain others of originally no greater potential worth. If among the latter there be the usual amount of selective marriage, a degree of homozygosity may be reached, in a progressively diminishing group, sufficient finally to maintain a self-perpetuating class, even though the individual families continue to be small.

The point of chief theoretical importance is the expectation that in a society where the family is a relatively important feature, general reduction in the number of children promises to act as a significant selective agency in segregating the population into strata much more quickly than would otherwise occur. The average size of its families may consequently become a factor in determining the evolutionary trend of a human community.

C. H. DANFORTH.

Stanford University.

MY firm conviction is that if widespread Eugenic reforms are not adopted during the next hundred years

or so, our Western Civilization is inevitably destined to such a slow and gradual decay as that which has been experienced in the past by every great ancient civilization. The size and the importance of the United States throws on you a special responsibility in your endeavors to safeguard the future of our race. Those who are attending your Congress will be aiding in this endeavor, and though you will gain no thanks from your generation, posterity will, I believe, learn to realize the great debt it owes to all the workers in this field.

LEONARD DARWIN,
Past President of the Eugenics Education Society of Great Britain.

FINALLY, we may inquire: Can we by eugenical studies point the way to produce the superman and the superstate? Progress will come slowly. Man is a poor subject for experimental study; still worse to get to apply to himself established principles. But I think we are justified in having faith that the future will bring precise knowledge in human biology, and education will establish the desired mores.

The past two decades have seen the new Eugenics rise from a mire of ridicule to the solid foundation of a recognized important social factor. It is probable that in the next two decades it will rise still further in public esteem and become regarded as *the most* important influence in human advancement. For, man is an animal, and permanent racial progress in eugenics, must be based on the laws of biology.

CHAS. B. DAVENPORT.
Director, Department of Genetics, Carnegie Institution of Washington.

IN so far as hereditary deforming chondrocysplasia is a relatively common and easily demonstrable affection, it lends itself admirably to study. The disease is a distinct clinical entity, characterized by (1) the occurrence of multiple more or less symmetrical cartilaginous and osteocartilaginous growths within and upon the skeletal system, generally benign, and resulting from a disturbance in the proliferation of the bone-forming cartilage, (2) the occurrence of certain typical secondary distortions and deformities of the skeleton, (3) the demonstration of inheritance in a large proportion of the cases.

DR. ALBERT EHRENFRIED.
Boston, Mass.

THE eugenical ideal must be that every one develops his gifts to enhance the value of his own person, that every one is tolerant with regard to other people's opinions and conduct and that every one is prepared to exert himself in the interest of the whole.

DR. G. P. FRETS.
Holland.

PENNSYLVANIA, because of its geography and industrial history, finds itself with many foci of mental defect. Many methods have been used in efforts to eradicate these foci, institutional care, special classes, supervision, group recreation (to prevent delinquency). Mental health clinics make a special effort at early identification of these defectives. All these methods reach only a limited percentage. The cost of these defectives in the community is constantly mounting, and other methods to eradicate them must be employed.

FLORENTINE HACKBUSCH.
Dept. of Welfare, Harrisburg, Pa.

SCAPULAR types are useful in studies of human inheritance; as morphological constants for correlating coexistent inherited variations, measurements and indices, and as indications of fitness in any people for health, disease, education and duration of life.

To determine who are the unfit, fit or fittest, equal consideration must be given the ever-present variables—inheritance and environment—and the discernible structural inherited variations peculiar to the individual. His family and stock must be recognized, classified, evaluated, and correlated.

The results of investigations, based upon the types of scapulae, justify the inference that the *ideals* of the Physician, Eugenist, Educator, Sociologist and Jurist, expressed *in social and racial improvement,* will be nearer realization through continuous research on inherited variations and fitness problems and that such research will lead to more accurate appraisal of individual fitness for health, disease, education, duration of life, mating and parenthood.

William Washington Graves. M. D.
Washington University, St. Louis, Mo.

THE most important causes of death may be conveniently divided into three groups, diseases of middle and old age, in which there is little selective action, and little or no reduction in the death rates, diseases of children as well as of adults, in which there is a moderate selective action, and some reductions in the death rates, and diseases almost exclusively of infancy and childhood in which there is a marked selective action, and in which there is a great reduction in the death rates. As the mortality in infancy and childhood decreases, the infections of the respiratory system become increasingly important. As the etiological factors are to a great extent beyond our control, the very common diseases, measles and epidemic catarrh with their often complicating pneumonia, become the chief agents in the selective elimination process. Different groups living under similar environmental conditions may present marked differences in the adequacy of immunologic reactions to the infectious diseases. These differences are due primarily to the amount of selective elimination of non-resistant strains that has previously occurred.

Charles Herrman.

MEDICAL science and care, widespread throughout the community, has resulted in survival over the reproductive period of life of many persons hereditarily diseased in mind or body. Figures are given for increasing insanity between 1859 and the present date, increase in certifiable feeble-mindedness in the last twenty years, and lastly, fall in physical vigour as shown by recruiting statistics. This paradoxical phenomenon is a clear example of the contra-selection postulated by Ploetz 30 years ago.

Cora B. S. Hodson.
Hon. Administrative Secretary, International Federation of Eugenic Organizations.

MIGRATION to the north brings the Negro into an unfavorable environment. The climate is against him and tends to aggravate the respiratory infections to which he seems to be peculiarly subject. Most of the northern Negroes live in cities and an urban environment is relatively more unfavorable to them than to the whites. Birth control is extensively practiced by urban Negroes. Its effect is quite evidently dysgenic as it has proven to be among the whites. How extensively it may come to be employed one cannot safely predict. Psychological influences, arising out of unsatisfactory relations to the dominant whites may possibly come to exercise a depressing influence upon the Negro birth rate, especially in urgan communities. If migration redounds to the biological advantage of our Negro population, as it has to many migrating people in the past, the Negroes will be compelled to overcome a number of handicaps and this requires the maintenance of a relatively high birth rate under conditions which will tempt them to restrict it.

S. J. Holmes.
University of California.

FINALLY, the colonies included families which became differentiated with respect to certain characters, being as remarkable for the lack of certain trait-complexes as they were for the possession of others. Diversity of "stamp" is illustrated by such families as the Adamses, the Lowells, the Dwights, Roosevelts, Wolcotts, Ran-

dolphs and Lees. The personalities which led in our distinctive development have been found to arise from the fortunate crossing of able lines, suggestive of the process we know today as emergent evolution.

This should have for us more than a mere academic interest. For, whatever the present crises, social and economic, may compass by bringing latent powers to the fore, we may not look to them to change materially the basic fabric of our society. That was established long ago in the germinal constitution of our people. How the traits arising from that constitution may be eliminated, conserved, combined and recombined must be the task of our social policies of the future. The present crises cry aloud for effective leadership; failure of such leadership to appear is due to the dying out of highly gifted families, and the low fecundity of others, which though less gifted, would, if producing larger families, increase the chance of producing able individuals. This situation calls for vigorous remedial measures if American institutions are to proceed further along lines laid down by these leaders of the past.

WILHELMINE E. KEY.

Somers, Conn.

FOR ten years the Committee on Exceptionally Able Youths of the Civic Club of Allegheny County, Pa., has been mentally testing the most intellectually promising of the high school graduates of Allegheny County and granting its awards to the highest few. The minimum standard at present is the highest five per cent of the freshmen of an average American college. The number of such awardees on this basis has been 64.

This has given an opportunity to notice whether such attainments are wholly sporadic, directly proportional to schooling, or whether they "run in families" to a significant degree. At every test on the average there are two or more pairs of sibs or cousins included although this would be very rare by chance alone. However, where three sibs have been graduated it has been common for one or more not to be eligible, or not to win an award.

ROSWELL H. JOHNSON.

University of Pittsburgh.

IF the present rate continues, and there is no apparent reason for thinking it will not, by 1934 we will have more than one-half million people in our nervous and mental institutions, alone. One out of every 150 people in the United States during 1930 was a patient in a hospital of some kind. One out of every 290 people was a patient in an institution for nervous and mental disorders. Families that send a child to an institution for feeble-mindedness average twice as many as those who send a child to a university.

In 1928 it was estimated there were 10,000,000 people at large who were socially inadequate. They would include the mentally defective, the criminal, the blind, the deaf, the crippled, the germ diseased, the degenerative diseased, and all other dependents.

Deep seated changes are taking place in the quality and quantity of our people. Some of these changes are beneficial; others are detrimental. Statesmen must take heed of these changes and tendencies. Many of them are fraught with danger to the fabric of our country.

DR. J. H. LANDMAN.

New York, N. Y.

DURING the past ten years much light has been thrown upon the causation of human infertility, particularly in three respects. First, in the typical clinical case the cause is not some single abnormality, but a summation or totality or four or five factors, of which each lowers fertility to some extent while all together depress it below the threshold of conception. Second, in the great majority of cases the responsibility is divided between the two partners; the situation is not, therefore, that of a fertile man married to a sterile woman, or vice versa.

but rather a mating sterile because both of the partners are of subnormal fertility. Third, states of constitutional depression, both endocrine and nonendocrine, are causative factors of infertility fully as important, in the aggregate, as are local abnormalities of the genital organs.

CHARLES H. LAWRENCE, SAMUEL R. MEAKER, ALLAN W. ROWE and SAMUEL H. VOSE.
Evans Memorial Hospital, Boston, Mass.

INASMUCH as the practitioner in his student days has been taught little of inheritance in disease; and has not had his interest aroused as to its significance, he fails most frequently to record his own observations in this field, or if he records them, they may be in such form as to furnish little of useful information to the trained scientists, studying inheritance of disease in man.

Until the medical practitioner is made aware of the importance of heredity as an etiological factor in the production of disease, he will not be apt to have a sympathetic attitude toward public education nor toward any scheme which may be devised to curtail the heavy economic waste of caring for the hereditarily defective. For these reasons, a sound eugenic measure, and one which will bring in large returns in professional and public interest, and which will serve to give far more data on human inheritance than we have at present, is the agitation to have taught in every medical school, not only a more extensive course of the fundamentals of genetics in premedical courses, but the application of this science to problems of human disease. This course should be taught by a medically trained person, familiar with the field of genetics, and it should be taught during the final year of the medical course, when the student has become familiar with the signs and symptoms of disease.

MADGE THURLOW MACKLIN.
University of Western Ontario.

ONE of the effects of this growing interest in our subject is an increased demand for eugenic prognosis. More and more persons contemplating marriage, who have ancestors or collateral relatives exhibiting some hereditary disability, are applying for advice as to the chances of their children being affected by such and such a disease or disability. In the present condition of our knowledge of hereditary diseases it is by no means safe or easy to give advice in such cases. With a view to remedying this deficiency our Secretary, Dr. Blacker, is now engaged in editing a book, to which medical men with special knowledge of diseases recognized as hereditary are contributing, in order to place before the general practitioner the information at present available for giving eugenic prognosis. It is hoped that the publication of this book will stimulate the production of more accurate and abundant data than at present exist. And in this connection I may add that Dr. Blacker has prepared a schedule for recording the pathological elements in pedigrees, and also a second schedule designed for the preparation of full pedigree records for genealogical purposes in such a way as to bring out their eugenic aspects.

Although, then, I cannot claim that any real impression has yet been made upon the fertility of those individuals and classes whose reproduction must be considered racially undesirable, this brief account of the recent activities of the Eugenics Society, and especially its concentration on the questions of the Social Problem Group and Sterilization, will show that steady advance is being made. The importance of the subject of Eugenics is now much more generally recognized than at any previous period, both by the leaders of public opinion in this country, and by the public at large.

SIR BERNARD MALLET.
President, Eugenic Educational Society of Great Britain.

THE vital thing, for the population at large, is a relatively low rate of multiplication of those who are, in general, physically and mentally less well endowed, without a decrease in the total size of the population; or, to put the same thing conversely, a relatively high multiplication rate of the genetically sounder germ plasm, *all along the line*. Ideally, the rate should be a function of total genetic worth, there being, from this point of view, no ultimate distinction between negative and positive eugenics. However, the better the genes, especially if they be rare, the more important is what happens to them. Since Galton's time, absolutely no headway has been made in realizing this major aim; in fact, it is widely claimed by eugenists themselves that just the opposite process is increasingly operative, despite their own preachments.

We might as well admit that the forces at work are quite beyond the control of us as eugenists, in the society in which we live. For they are fundamental economic forces. Galton lived too early to appreciate the principle brought out by Marx that the practices of mankind, in any age, are an expression of the economic system and material technique existing in that age. He thought that they could be moulded willy-nilly, from without, into conformity with the abstractions of an idealist intellectual. But the organization of society today is such as to make the primary motive of action, at least among the dominant section, the profit motive. This motive works out in devious ways that are contradictory to the welfare of the race as a whole, despite the fact that some of our modern philosophers, in a defense reaction try to rationalize the two ends into harmony.

H. J. Muller.

University of Texas.

THIS International Congress is singularly opportune. It is not merely an academic problem we are met to discuss, or a problem of the future. It is not a theory but a condition which confronts us. It is a problem of the immediate present, and, like all sociological problems, the more fascinating because of its very complications. Man does not rise to his best endeavor in face of small problems; it is in the genius of modern humanity to meet and attempt to solve the most difficult. Eugenics is not a human invention by Francis Galton or any of his predecessors or successors. It is a long-known and universal natural law, namely, the survival of the fittest and the elimination of the unfittest. * * *

Prisons, reformatories, asylums, great public financial offerings, great national and local appropriations, great tides of human kindness and generosity, are merely palliatives and temporary expedients. They may for a time gloss over the cataclysm; they can not permanently cure it or avoid its recurrence. *The only permanent remedy is the improvement and uplift of the character of the human race through prolonged and intelligent and humane birth selection aided by humane birth control.* This is the burden of my address; it is the keynote of our third congress.

Henry Fairfield Osborn.

Hon. Vice President, Third International Congress of Eugenics.

AS every phase of living conditions affects the quality of the human stock, so for the success of any eugenical program accurate data upon environment is absolutely indispensable, and for the fullest development of the innate qualities of the old pioneer families or of recent importations, the people themselves must be appraised, reminded of their finest traditions, made aware of progressive movements in other communities and encouraged to develop a more wholesome, optimistic attitude and greater pride in the traditions and the possibilities of their community.

H. F. Perkins.

Director, Eugenics Survey of Vermont.

THE pressing need is for the other states of the Union to adopt laws as rigid as that of Virginia against racial intermarriage, and for the creation of public opinion against social and school intermingling of the races, which leads to marriage and ultimate destruction of race purity.

Separation of the races is the only true remedy, and to this end the Garvey "Back to Africa" movement should be encouraged.

By the extension and rigorous enforcement of the Virginia policy of racial integrity, it is possible to at least postpone the day when there will be but one race in America, a brown or yellow one, inferior to the present dominant race and not greatly superior to the one which was in the past, and still is, largely the servant race.

W. A. PLECKER, M. D.
Richmond, Virginia.

▼

ONCE in a while, of course, it is possible to advise people who are about to marry, as to whether they should or should not have children. But again such advice would usually be too late, and at best only a few couples could be affected in this way. While any gain is useful, it is futile to hope that the problem of engenics can be affected materially by such trivial procedures. It will be solved only by mass-measures, so to speak, dealing with the five great factors that make or break a nation: war, immigration, contraception, higher education, and charity.

PAUL POPENOE.
General Director, Institute of Family Relations, Los Angeles.

▼

IN studies on the inheritance of mental disease, one important factor has usually been neglected—the direct environmental effect on the children of the unstable parent or parents in the causation of mental disease in the child, quite apart from any inherited constitutional tendency. The problem is infinitely more complicated than most studies in genealogy indicate. It is true that the dynamic concept of mental development postulates that experiences in childhood lead to a neurosis or psychosis only when the constitution of the individual is phylogenetically predisposed to such reactions, but, it is also true that these experiences act as the pathogenic factor in the etiology of the disease. Normally, every child has to make an adjustment between his instinctual desires and the social aims and ideas of the milieu in which he is reared. The energy of the instincts which society says may not find direct expression must be eliminated or repressed, and this process starts practically from birth. The opportunity to live out the instinctive wishes varies widely in different cultures, but the chance to find outlets through which the repressed tendencies can find some acceptable expression varies, not only with the broad social milieu, but with the immediate surroundings.

FLORENCE POWDERMAKER, M. D.

▼

ONLY rarely is a family specific for one form of allergy. Crosses with negative lines show that an individual with one allergy may pass on various other types to his or her children. There is no evidence that allergy is due to one factor and each type due to a special modifying factor, for the possible modifying genes which must be dominant and which might be brought in by the negative line in these crosses do not produce the same type of allergy in any proportion of the offspring, but, on the contrary, the new types of allergy in the F_1 are of various kinds.

Migraine is more common among females than among males. Crosses between migraine individuals and negative lines show that a male may inherit migraine from either his father or his mother. Migraine is thus not sex linked but the reason for this difference between the sexes is probably to be sought in the physiological differences between them.

M. H. RICHARDS and R. M. BALYEAT.

ALL nations shall possess the right to practice a complete biological research, (somatic and germinal), of individuals declaring their intention to reside within the territory; or may prohibit the residence or limit the time of that residence, to aliens from those countries refusing to comply with the investigation or research herein stated. The same rule shall be applied to all individuals who after investigation, prove to be liable to hereditary transmission of any undesirable quality.

D. F. RAMOS.

Havana, Cuba.

▼

A STILL further Indian contribution to civilization, closely associated with the esthetic and spiritual, is the social organization of the small community. It is not merely that Indian social organization may be interesting historically to students of western democracy; it is rather that in its survivals of community arts, village industry, and wholesome rural life, there may be a way out for American industrialism.

The real task, whether in terms of races or individuals, is to encourage and stimulate talent wherever found. Gifted individuals among Indian groups must be aided; the significant Indian contribution in the fine arts must be saved and advanced. In our program of education and adjustment today with Indian people we must somehow find the way to accept understandingly the living contributions they have made and can make to our civilization.

W. CARSON RYAN, JR.

U. S. Indian Service.

▼

THE men at this co-educational college married exactly as much as the general male population of the United States, while at Harvard one quarter remain single. In every decade since 1873, one third of the co-educational women have remained single except that after the crisis of 1893 this third became, alas! two-fifths (two-fifths being the custom at all times in the large women's colleges, according to Whitney and Huntington).

Analysis of the birth deficiency: Among the men the causes were (a) late marriages, (b) great *excess* of one—or no—children in the early marriages—men of impaired health and of inferior personality, and also high-school teachers, being excessively represented; (c) no families of more than five, except in two cases, both college professors. Wealth was favorable to fertility in both men and women, as the 81 men on the "special contributors" list of the college had more children than necessary to replace themselves and 52 women also had.

Among the women, the deficiency was due to about the same causes, dreadfully augmented, however, by the prevalent celibacy. An exhaustive examination of their intellectual ranking by five separate methods showed that those ranking over 90 (or over 80 in mathematics alone) usually married much less than the rest, but those who did marry had so many more children than anyone else that they kept up the per capita for all honor graduates to a point exceeding the average. The five women who had six children or more were all wealthy, and all had fine minds.

CAROLINE H. ROBINSON.

Tunkhannock, Pa.

▼

I HAVE outlined several measures by which the fertility of the gifted could be encouraged. If I do not consider them all equally important, and if I doubt whether some of them are really practicable, I am nevertheless convinced that every means at our disposal should be made use of to achieve our aim. I do not cherish the hope that the measures I have proposed will or can all be put in immediate operation, but they do include a few for which the time is now ripe. It is possible to make the essence and aim of eugenics known by means of propaganda on a large scale; literature, lectures, the stage, the pictures, broadcasting can all be pressed into the serv-

ice of eugenic reform. It is possible to urge upon the governments the necessity of giving tuition in eugenics and genetics of making the study of both compulsory in the training institutes which come into consideration for this object. It is possible to secure here and now the cooperation of the Church. It is possible to accelerate the education of gifted children. It is possible to convince the governments of the necessity of reforming the system of taxation in the interest of eugenic principles, without increasing thereby the State's financial burden. All these measures can now be put to the test. It goes without saying that they cannot be confined to only one country. The International Eugenics Society must be the controlling spirit and frame our policy. It will then be for the national societies to carry out this policy adapting it to the conditions obtaining in the several countries.

J. SANDERS.
Physician, Rotterdam, Netherlands.

THE gradual extinction of the aristocracy is of social importance only on the supposition that the artistocracy represents the selection of the fittest, that it inherits the qualities which distingished its ancestors, and that its disappearance will deprive the body politic of a valuable ferment. But apart from the fact that in many cases families were ennobled by the caprice of the Sovereign rather than for their intrinsic merit, the social loss implied in the extinction of the legitimate male line would only hold good if it coincided with the biological extinction of the family, which may well continue through female or illegitimate descendants to bring its special contribution to society.

FRANCO SAVORGNAN.

THIS apparent constancy in the results of the Seashore measures of musical capacities reveals their prognostic value. Herein lies their greatest scientific value. On the basis of information available from repeated tests for the same individuals over a period of time, the Seashore Measures of Musical talent are recommended as scientific tools to be used in basic studies of musical inheritance in famillies.

HAZEL M. STANTON.
Eastman School of Music, Rochester, N. Y.

APPARENTLY, the important fact is that it is not the actually insane who constitute the real problem of mental disease. The carriers are more dangerous than the cases. The control of the development of insanity means that preventive work must be brought to bear on the carrier and this should begin in infancy.

E. BLANCHE STERLING.
U. S. Public Health Service.

THE American Negro population of the future will probably be more homogeneous as to ancestry, i. e., there will be a smaller percentage of unmixed Negroes, a large percentage with half or more Negro ancestry, and a smaller percentage who pass as Negroes but have more White than Negro ancestry. The segregation process operative in the inheritance of pigmentation will prevent the development of a population of one uniform hue.

IRENE BARNES TAEUBER.
Mt. Holyoke College.

CONTRASTING NORMAL AND "SELF-PRUNING" INFLORESCENCE TYPES

Figure 1

The normal inflorescence (above) recurs very regularly on every third internode along the stem. "Self-pruning" clusters (below), in marked contrast, are typically repeated on every or nearly every internode, until the growth of large fruits causes the cessation of growth of the main axis. "Self-pruning" is a recessive character.

INHERITED CHARACTERS IN THE TOMATO

1. The Self-Pruning Habit

JOHN W. MACARTHUR
University of Toronto and Ontario Agricultural College

VARIETIES of the common tomato that are called "self-pruning" are of comparatively recent origin. About eight years ago Burpee's Self-pruning was introduced and disseminated as a variety, whose "plants do not require any pruning, due to their limited branching habit. The fruits are borne profusely all along the vine." Yeager[3] described and illustrated its "remarkable characteristic of determinate growth, producing blossom clusters at the tips of the branches" and emphasized its possible economic value for securing a variety that would ripen most of its fruits before frost.

A more essential and invariable feature in the self-pruning habit is something which is not specifically mentioned in either of the above descriptions, but which is well illustrated in Yeager's figures and in Figure 1, namely a unique spacing of the inflorescences along the stem.

All tomatoes—currant, cherry, pear, peach, and the common large-fruited varieties, including Globe, of which self-pruning is quite evidently a mutant derivative—normally produce the first blossom cluster on the ninth to the thirteenth internode and then repeat the inflorescences regularly every third internode thereafter all through the growth of the stem (Figure 1 above). The main stem, apparently simple and straight in growth as by the continued development of a terminal bud, is really sympodial, composed of a somewhat zigzag series of superposed branches, which continue the same general direction of growth. Each of these branches, or segments of the main stem, terminates after three nodes (and leaves) in an apical inflorescence, opposite the base of which a new auxiliary bud appears; from this arises the next stem of three nodes. This is repeated indefinitely until a long succession of fruit and flower clusters are found all along the seemingly monopodial axis. Since each peduncle is adnate to the stem for a short distance, it appears to arise from the internode.

Two prominent variations from this type occur: (1) the compound inflorescence where each segment of the stem is six internodes long and the flower cluster is very large and much-branched; and (2) the self-pruning, where some of the stem segments are shortened to one or two internodes. In the latter the flower clusters begin at the usual height and then tend to recur on every internode or every second internode; they sometimes skip three leaves, but are then invariably closely spaced again. If fruits set on these clusters nutrition seems to be diverted to them and further terminal growth of the stem segments ceases. Leaves are seen to be interspersed among the close set clusters. Distinct laternal branches arise from the nodes immediately below, and then more basally, on which inflorescences soon appear in similar close succession. The result is that the self-pruned plant covers a much smaller circle of space than do normal plants, but covers this more densely.

The Genetic Behavior of Self-pruning

In crosses of self-pruning with normal plants the F_1 hybrids all produce their blossom clusters in the normal succession with three intervening leaves, the stems are indeterminate in growth, and the plants cover much ground. As

Yeager[3] suggested, self-pruning is a recessive character. In the F_2 a simple and clean segregation occurs on a monofactorial basis. The ratio of 716 normal:202 self-pruning plants shows some deficiency in numbers of the latter class, but the deviation from 3:1 is only twice the probable error and not significant. The back-cross ratio obtained, 83 normal:93 self-pruning is a closer fit to expectancy. As symbols for this pair of genes we have used[2] *Sp* and *sp*, but Yeager's[4] *T* (for indeterminate) and *t* (terminate) are equally descriptive and more brief.

Linkage Relations of the Self-pruning Gene

Self-pruning has been crossed with linkage testers containing fifteen genes already described,[2] that now appear definitely located in seven "chromosome groups." The various F_2 dehybrid repulsion ratios and the cross-over values (Calculated from them by Immer's tables[1]) which are given below, show that independent assortment probably takes place between *Tt* (*Sp sp*) and the following pairs: *Dd* 52.7 ± 2.3; *Pp* 46.4 ± 6.5; *Oo* 51.9 ± 6.0; *Rr* 60.0 ± 4.2; *Yy* 49.6 ± 2.0; *Br br* 57.8 ± 3.3; *Ff* 49.1 ± 2.3; *Aa* 53.4 ± 3.3; *Ll* 54.7 ± 3.2; *Hh* 55.1 ± 3.0. The special features of the phenotype relationship between self-pruning and the two other atypical forms of inflorescence, compound (*s*) and leafy (*lf*), will not be described here.

The above genes represent groups I to VII, excepting only group IV with whose marker, potato leaf (*c*), self-pruning exhibits a very strong linkage. The repulsion ratio, 117 *CSp* : 50 *Csp* : 52 *cSp* : 0 *csp*, indicates the closeness of this association. One of the *Csp* plants was recognized as heterozygous *Cc*, and produced 25 per cent double recessives. In the back cross generation from F_1 (*Csp* × *cSp*) × *csp*, the ratio was 3 *CSp* : 90 *Csp* : 81 *cSp* : 2 *csp*. Here the intensity of the linkage can be efficiently measured, the cross-over percentage being 2.83 ± 1.9.

The IV linkage group of the tomato, accordingly, contains the loci of *Cc*, controlling cut-leaf and potato-leaf, and *Spsp* (or *Tt*), controlling the normal and self-pruning habits.

Literature Cited

1. Immer, F. R., 1930. Formulae and tables for calculating linkage intensities. *Genetics* 15: 81-98.

2. MacArthur, J. W., 1931. Linkage Studies with the Tomato. *Trans. Roy. Can. Inst.* 18: 19.

3. Yeager, A. F., 1927. Determinate Growth in the Tomato. *This Journal* 18: 263-265.

4. ———— 1931. Correspondence.

Breeding Karakul Sheep

DAS KARAKULSCHAF UND SEINE ZUCHT (The Karakul Sheep and Its Production), *by* G. Froelich. 148 pages, 43 figures. Price in paper covers, 8.50 marks, cloth 10 marks. F. C. Mayer, Munich. 2nd edition. 1931.

THE Institute of Animal Breeding at the University of Halle for many years has been a center for breeding Karakul Sheep. G. Frőlich, the director of the institute, here presents valuable information concerning the breeding and management of animals of this breed. The author first gives a short history of the breed and a report concerning the present distribution and the ability of acclimatisation of Karakuls. This is followed by a detailed account of the different breed characters, with special reference to hair and skin. Different methods of breeding Karakul sheep are described. The inheritance of the most important Karakul characters is discussed. The concluding chapters deal with management, fur production, and hygiene. There is an extensive bibliography. On the whole, the book is a well-balanced and non-technical account of the most important problems of breeding and raising Karakul sheep. There are many instructive illustrations.

W. Landauer.

Connecticut Agricultural Experiment Station.

INHERITANCE OF WHORLS IN THE HAIR OF SWINE

JULIUS E. NORDBY*
University of Idaho, Moscow, Idaho

THE investigation of whorls in swine was prompted a number of years ago because of their prevalence in commercial and purebred herds. In an observation of 12,000 market hogs Craft[3a] found 1.4% affected with whorls. Breeders and judges often hold different views on the significance of whorls in breeding swine. Definite information on the problem was not available and extreme views were not always reconciled, especially in the showring.

Whorls have been known for a long time to occur on the neck, rump, and loin coupling along the spinal column in swine. They occur in the inguinal and post-humeral regions also and are common to the middle and lower cervical areas. Frontal and nasal whorls are common. The whorls that occur along the spinal column are the most conspicuous and it is these whorls that are especially discriminated against in purebred swine. The secretaries of ten purebred swine Breed Associations, who handle over 95 per cent of all pure bred swine registrations in the United States are in accord in considering whorls as a "serious objection especially in boars" and advise that "accepted judges of the various breeds will not place a hog in the money when it has a whorl." Two of the breed associations disqualify for registry animals which have a whorl. (Informamation supplied by correspondence.)

A study of the relationship of pigs that had whorls was made at this station in 1922, and in the following year a definite breeding program was started. The preliminary study indicated that this defect might be a Mendelian character. If the heritable nature of the whorls could be established it would be of considerable economic importance to breeders.

The hair along the spinal column, and, for the most part, along the sides in swine is normally rather simply arranged. In general, the hair slopes downward and backward ventro-caudally. Variations in the direction of the hair-stream along the spinal column are not uncommon. The hair in such areas opposes in varying degree the normal hair stream. The center of the disturbance is usually on the median line (Figure 4). The affected areas in nearly one hundred cases observed, including those shown in the chart (Figure 5) have been limited to the neck coupling at the top of the shoulder or immediately anterior to it (dorso-cervical) (Figure 4), to the lion (lumbosacral), and rump (sacro-caudal) region (Figure 3). Defects in the hair stream in the rump region may often be found at the base of the tail.

Hair whorls in the area of the neck in the specimens discussed in this paper were, as a rule, comparatively small and often less complete in their symmetry than those caudally located (Figure 3). Disturbances in the normal hair stream on the loin and rump are often very large and occupy almost the entire space from the base of the tail to the last dorsal vertebra. The experimental subjects, in Figures 2 and 3 show typical examples of such large disturbances. It is common practice to recognize all the variations in the normal hair stream along the spinal column in swine as whorls or swirls even though there are essential differences in their pattern detail, some of which can scarcely be defined as whorls. For convenience in this paper, the term whorl will be used in general to designate all types of disturbance.

---

*Paper No. 80 from the Department of Animal Husbandry, Idaho Experiment Station. Published with approval of the Director.

Kidd[5] has recognized three closely associated elements, which he groups together as one phenomenon; namely, whorl, feathering, and crest. When whorls are found alone they may have a clockwise or counter-clockwise direction. Eschricht,[4] Voight,[12] Brewster,[1] and Lauterbach and Knight[7] have reccognized the right and left whorls in the head of the human. In general, the disturbances included in this study have a central point from which they seem to start (Figure 2-*C*). From this central point, the hair spirals right or left, either coalescing rather smoothly with the normal hair stream or opposing the normal hair stream vigorously and being brought to a sudden stop in a crest (Figure 2-*A*). The feathering (Figure 2-*B*) seems to have its origin in a whorl for the most part. Some exceptions to this seemed to occur, in which the feathering did not seem to have a definite connection with a whorl. The feathering disturbances that occupied a part of the rump area and extended to the loin coupling seemed to become more vigorous in opposing the normal hair stream up in the loin coupling area and terminating in a very definite crest. Craft,[2] in describing a whorl, says: "The hair forms a whorl similar to a back-wash in a stream of water."

Small disturbances which are likely to be overlooked may be found at the base of the tail. These are largely of the feathering pattern. Asymmetrical feathering was also in evidence and occurred for the most part in the area of the neck (Figure 4-*B*). The crest was not always in evidence as there is considerable variation in the manner in which the anterior margin of the disturbance opposes the normal hair stream. Apparently, the center of these disturbances was on the median line of the spinal column.

Permanency of Whorls

Craft,[2] in his study of whorls in Poland Chinas has observed the tendency for whorls to disappear in some specimens when they were about twelve weeks old. This tendency has not been observed in the specimens involved in these studies. In some cases, however, where the original normal hair stream disturbance was small, there was a tendency for the defect to be progressively less conspicuous toward maturity. When only a few hairs are involved in a hair disturbance, their direction may be forced to coalesce more smoothly with the normal stream as it grows longer and stiffer with age.

Whorls Are Inherited

Craft,[2-3] has found that the "swirl is hereditary, and is transmitted through both the sire and dam." The author[8] has previously reported the inheritance of whorls in swine. It is the purpose of this paper to analyze the available data from 27 litters of pigs for the inheritance of whorls. From a total of 253 pigs, 194 were free from whorls and 59 had whorls. In twenty-two litters produced by sows which were carriers of the hereditary influence or which were affected with whorls, 141 pigs were produced without whorls and 59 pigs or almost 30 per cent of the total had whorls. When both parents were affected with whorls 46 per cent of the progeny had whorls. Under similar conditions Craft,[3a] in working with Poland Chinas, found 59 per cent of the progeny with whorls.

Location of Whorls

A record is available in Table II of the location of the whorls but no attempt is made in this paper to explain the probability that there may be a separate factor or factors associated with the factors that produce whorls, which determine the location of the whorls. Landauer,[6] in reviewing the study of whorls in guinea pigs made by Pictet, Ferrero, and Guyenot calls attention to five zone centers where whorls are located, namely, near the base of the tail, loin center, to the front and rear of the loin, and on the neck. In January, 1932, Landauer supplied the author with more recent observations of later contributions from

WHORLS IN CAUDAL REGION

Figures 2 and 3

Typical cases of hair disturbances in the caudal region in swine. The elements of a whorl are indicated in the left-hand picture, where *A* indicates the crest, *B* the feathering, and *C* the center of the whorl.

Pictet and Ferrero.[10] He points out that whorls in the guinea pig are dominant over smooth hair and if the gene *R* for whorls alone is present, the animals have "localized" whorls only in the loin region. There is also a second dominant gene, *G*, which, if present in the heterozygous or homozygous condition, causes whorls to be "generalized" and to appear in the coccygial and neck regions in addition to the lion area. The gene *G* can be expressed only in the presence of the gene *R* for whorls. Also, a third independent gene *D* is postulated by Pictet and Ferrero which determines whorls on the head. This gene also needs the presence of *R* for expression.

In swine it often happens (Table II) that whorls will appear on the neck and in no other place along the spinal column. The pig shown in Figure 4-*B* had the hair defect only on the neck. Whorls on the head are very common in swine. They are located, as a rule, midway between the snout and eyes. They do not appear to be inherited as are head whorls in guinea pigs. In swine they occur apparently independently of whorls along the back.

It will be noticed from Table I that sows 22, 32, 33, 34, and 35 had whorls at the neck coupling and 32 and 35 had in addition, whorls on the rump. Two litters of sow 22, showing a whorl at the neck coupling, when mated to boar 17 with a whorl on the loin coupling, produced 17 pigs of which 5 had rump whorls and 6 neck whorls. Sows 33 and 34 (with whorls on neck) and sows 32 and 35 (with whorls on neck and rump) produced, when mated to boar 37 (which carried both neck and rump whorls), 7 pigs with rump whorls and 15 with neck whorls. The swirl over the shoulder has not been observed so far in the experimental stock used by Craft.[3a]

There were 62 whorls involved in 59 pigs affected of which 32 were in the rump-loin region and 30 in the neck-coupling area (Table II). Nine of the pigs with neck whorls were produced by matings which did not show the neck whorl and 21 were produced by sows which had a neck whorl. Two sows, 33 and 34 (each with one neck whorl), produced, when mated to boar 37 (with one whorl on the neck and one whorl on the rump), 1 pig with rump whorl and 11 with neck whorls. It would seem, therefore, that there is a separate genetic influence which determines the location of whorls.

Foundation Boars

Boars 100 and 101 in the Inheritance Chart, Figure 5, were used for a while in the Experiment Station Herd. Both boars sired too high a percentage of pigs with whorls. These boars did not seem to carry the same inheritance for

TABLE I.—Hair Disturbance in Affected Males and Females

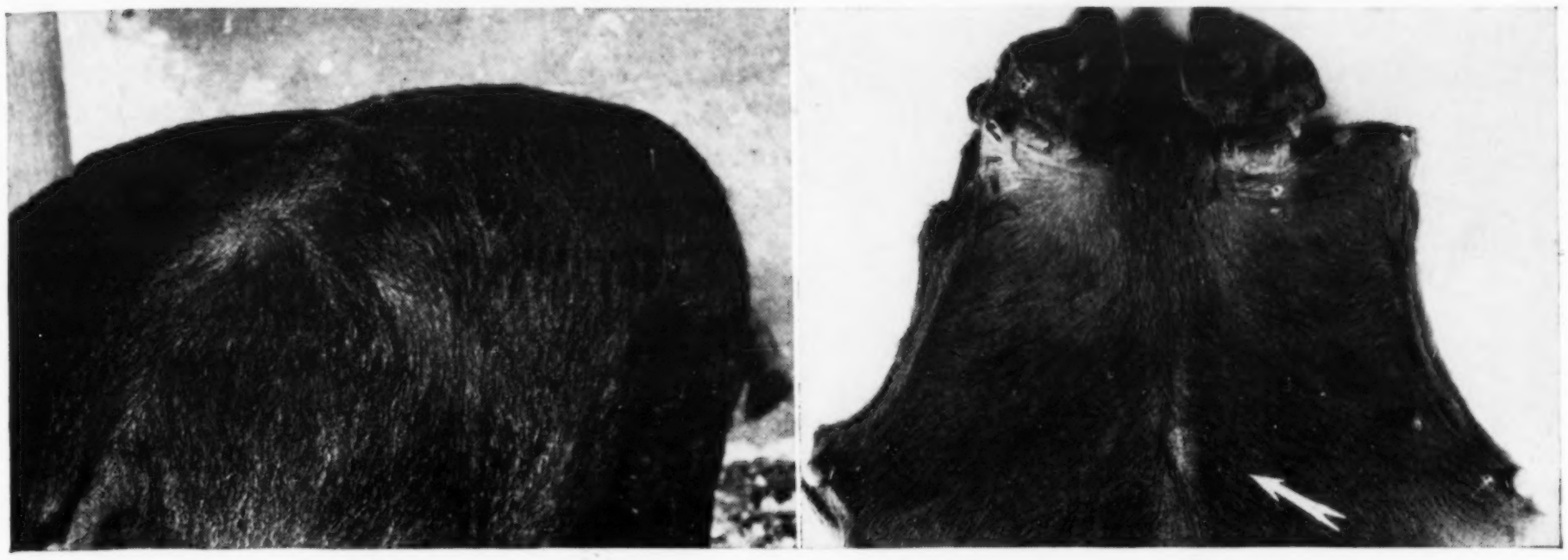
Male
- 17 Large whorl on rump and feathering forward to loin coupling.
- 37 Large whorl on rump and feathering over loin coupling. Small whorl at neck coupling on backline.

Female
- 22 Small whorl at neck coupling.
- 23 Large whorl on rump.
- 32 Small whorl and feathering on rump, and neck coupling.
- 33 Small whorl and feathering at neck coupling.
- 34 Large whorl and feathering at neck coupling.
- 35 Large whorl and feathering on rump, and neck coupling.

TABLE II.—Distribution of Hair Disturbances on Basis of Sex and Location Involving 27 Litters—194 Normal and 59 Affected Pigs. (All disturbances Noted Here Are on the Middle Line of the Back). *W* = Whorl; *F* = Feathering; (—) = Whorl and Feathering in Both Locations.

					Location of hair disturbances			
					Rump and loin coupling		Neck Coupling (dorso-cervical)	
Dam	Sire	Size of litter	Normal hair	Affected	Male	Female	Male	Female
1—	100*	10	10					
3—	101*	11	11					
6—	101	9	9					
7—	100	10	10					
8—	101	13	13					
2*	100	11	10	1	1W			
4*	101	7	5	2	1W	1WF		
5*	101	9	8	1		1W		
7*	101	8	7	1		1WF		
9*	101	9	4	5	2WF	1W		2WF
10*	101	10	8	2		1W		1WF
25*	24*	8	5	3	2W	1W		
25	43*	11	10	1			1W	
26*	43	10	8	2	1WF	1W		
27*	43	9	8	1			1WF	
62*	43	8	7	1				1WF
63*	43	10	9	1		1WF		
71*	43	9	8	1		1WF		
71	43	9	7	2			1W	1WF
16*	17**	10	7	3	1WF	1WF	1WF	
22**	17	11	9	2	1WF	1WF		
22	17	6	0	6	1WF(—)	2WF(—)	1W 1WF(—)	2WF 2WF(—)
23**	37**	10	8	2	1WF	1WF		
32**	37	7	4	3	2WF			1F
33**	37	9	2	7			5WF	2W
34**	37	10	5	5	1F		2WF	2F
35**	37	9	2	7	1W 1WF	1W 1F	3WF	
					5W	6W	3W	2W
		253	194	59	10WF	9WF	13WF	9WF
					1F	1F		3F

— unknown
* carrier
** affected



A B

TYPICAL HAIR WHORLS

Figure 4

Whorls in the neck region in two pigs. The location of whorls seems to have a genetic basis, as the location of the whorls has been observed to be inherited.

whorls inasmuch as sows mated to boar 100 would often produce pigs with a whorl when the same sows mated to boar 101 failed to produce pigs with a whorl, and vice versa. Boar 100 mated to sow 7 produced no pigs with a whorl. However, when sow 7 was mated with boar 101, one pig with a whorl was produced. A probable reason for this will be discussed later in this paper. Matings were planned with a view of combining the inheritance of these two boars in such a way that their genetic constitution as regards to whorls might be determined.

Inheritance Not Simple

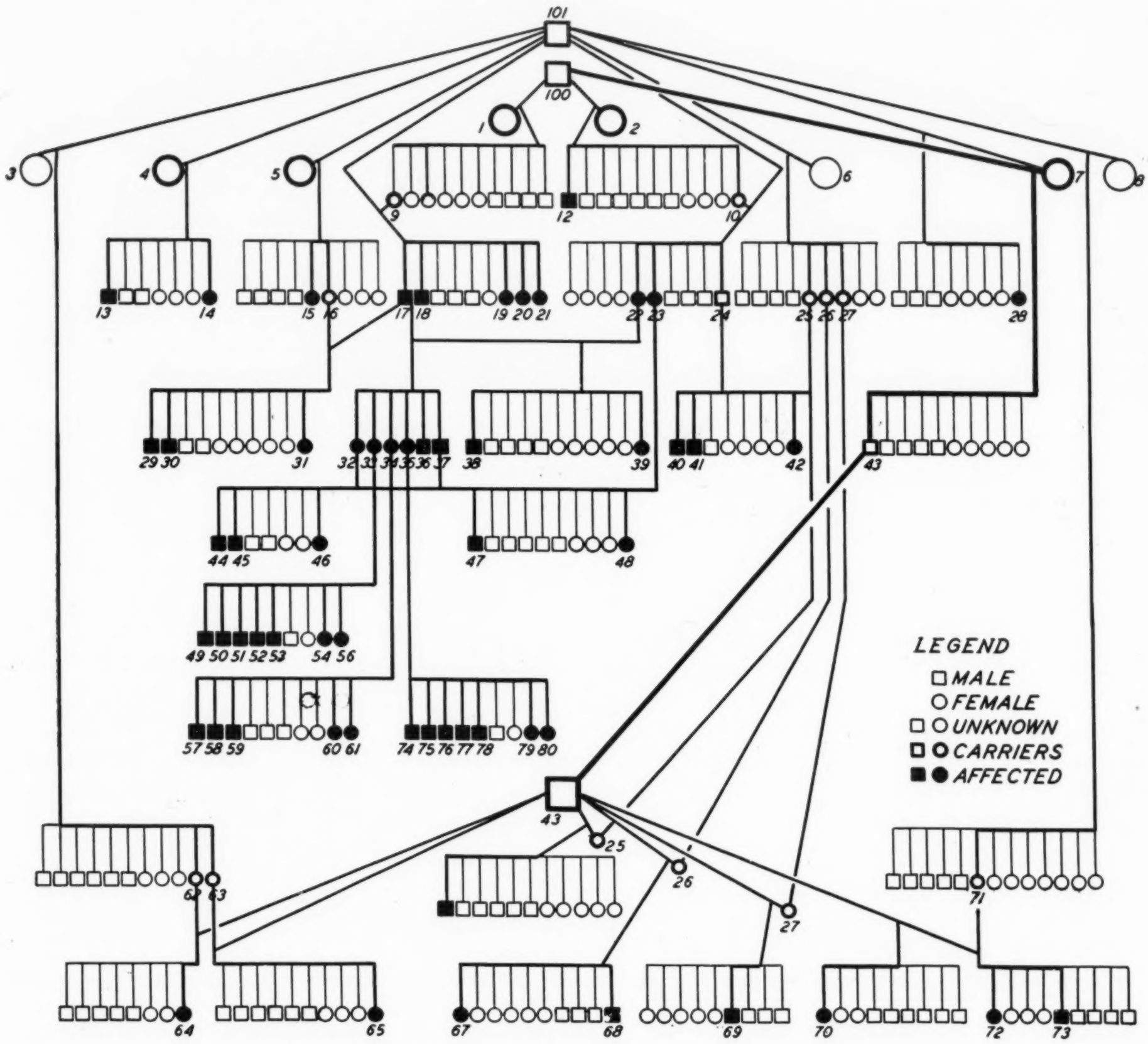
The author[9] has previously reported that the inheritance of whorls is not simple. As a rule, smooth haired parents did not produce more than two or three pigs in a litter that had whorls, and for the most part only one pig with a whorl was produced in each litter. One exception to this occurred when boar 101 was mated to sow 9. The litter produced had five affected and four smooth haired pigs. At first thought the inheritance might seem to be a simple recessive. However, were that the case, then boars with whorls such as 17 and 37 should have sired litters in which all pigs carried whorls when mated to sows that had whorls. Instead, such matings produced both whorled and smooth-haired pigs. It seems rather obvious, therefore, that the inheritance is not of a simple type.

Probably Two Dominant Factors

A two-factor hypothesis* has been used to explain the inheritance of whorls: *W* and *W'* are assumed as factors for whorls, both of which must be present in the homozygous or heterozygous condition before whorls manifest themselves. A pig homozygous for whorls would be of the composition *WWW'W'*. Since the factor for whorls is in all probability dominant, then pigs with the following composition would have whorls: *WWW'W'*, *WwW'W'*, *WWW'w'* and *WwW'w'*. On this basis pigs free from whorls would carry only one or the other of these factors in the homozygous or heterozygous condition or be homozygous for their allelomorph as follows: *WWw'w'*, *wwW'W'*, *Www'w'*, *wwW'w'* and *www'w'*.

This hypothesis does not explain fully the occurrence of only one pig with a whorl in so many litters produced from matings of smooth haired parents. On the basis of this hypothesis, pigs with whorls will appear only with the following matings of smooth haired parents: *WWw'w'* × *wwW'w'*, *Www'w'* × *wwW'W'*, *WWw'w'* × *wwW'w'* and *WWw'w'* × *wwW'W'*.

*The hypothesis of two interacting dominant factors was suggested to the author by W. A. Craft, January 18, 1929, as a possible explanation for the inheritance of whorls in swine. A further discussion of this hypothesis has been made more recently by Craft.[3a]



RELATIONSHIP OF PIGS WITH HAIR WHORLS

Figure 5

Pedigree chart showing the relationship of descendants of boars 100 and 101, assumed to carry complementary dominant factors for whorls.

These matings would produce respectively the following percentages of whorled pigs: 25, 50, 50, and 100. In no case did all of the pigs in a litter, produced by smooth haired parents, manifest whorls, hence apparently no mating involved a sire and dam, one homozygous for one member of the pair of factors and the other homozygous for the other. As a result of 14 litters produced by smooth haired parents, 104 pigs were produced. Of these 24, or approximately 23 per cent, had whorls, and 80 (77 per cent), were smooth haired.

This result is approximately what would be expected if the sire and dam of each mating was each heterozygous for one factor of the pair. With the exception of sows 9 and 10, there had likely been very little opportunity for any one of the factors to become homozygous in the other smooth-haired sows involved, hence and average of over 23 per cent apparently agrees reasonably well with expectation.

Probable Associated Factors

If, as assumed, there are two factors for whorls and the homozygous condition for whorls is *WWW'W'*, then, in view of the fact that whorls

are found in different zones along the spinal column and confine themselves rather uniformly to these zones, and may appear in two or three zones on the same individual, it would seem that some explanation must be made to satisfy the factor of location. As previously pointed out in this paper, parents with whorls on the neck seem to produce offspring with whorls in the same zone and when the whorls are found in the rump-loin region in the parents, the largest percentage of the whorls which appear in the offspring will also be in this zone. Further study is required for a satisfactory analysis of the elements which determine the location of whorls.

Causes for Variation in Whorls

Since the hair disturbances vary in size, shape, and direction, it is probable that genetic factors also influence these variations. Landauer[8] points out that the generalized whorl form in the guinea pig is influenced genetically by one dominant factor and that the localized form is its recessive allelomorph. A complete genetic solution of this phase of the problem in swine is not possible with the data at hand.

Method of Eliminating the Defect

On the basis of the inheritance which seems to prevail it is imperative to discard both the sire and dam of the pigs that have whorls if the defect is to be

Probable Genetic Composition of Boars 100 and 101

It appears that sow 9 was homozygous for one of the factors. When she was mated to boar 101 she produced 9 pigs, five of which had whorls. Both sow 9 and boar 101 could not have been homozygous for different factors or 100 per cent of the pigs would have manifested whorls. It is very probable that boar 101 was heterozygous for one factor as he sired only 6 pigs with whorls out of a total of 34 when mated to sows 4, 5, 7, and 10, all smooth-haired. If he had been homozygous for one factor, fifty per cent of the pigs produced by these sows should have had whorls, as, no doubt, the sows were all heterozygous for the other factor. If we assume that boar 101 carries one factor, *W'*, in the heterozygous form (*wwW'w'*), then sows 4, 5, 7, and 10 would be of the constitution *Www'w'*. Sow 9 is probably *WW-ww*. Sow 1 could be *Www'w'* or *WWw'w'*. Boar 100 could only be *Www'w'* or else 50 per cent of the litter, when he was mated to sow 2 would have had whorls. Sow 2 is probably *wwW'w'* and sow 10 *Www'w'*, the *W* coming from boar 100. When she is mated to boar 101 the two factors *W* and *W'* are combined to bring out whorls. Boar 24 in this litter is, no doubt, *Www'w'*, and sow 25 *wwW'w'*, the *W'* coming from boar 101, since sow 6, as she farrowed no pigs with whorls, is probably *www'w'*.

Sow 7 has produced one litter to the service of boar 100 and one litter to the service of boar 101. When mated to boar 101 she produced a pig with a whorl. Hence she is probably *Www'w'*, and of the same constitution as boar 100. Otherwise she would have been expected to produce some whorls when mated to him. Boar 43, then, gets his *W* either from sow 7 or boar 100, and since he sires so few pigs with whorls, he is undoubtedly heterozygous for this factor.

Boar 101 is the sire of sows 25, 26, 27, 62, 63, and 71 and transmitted *W'* to them since their dams apparently were not carriers. Had they been carriers of the same factor then a larger percentage of the offspring of their daughters mentioned above should have manifested whorls. Had they carried *W* then they should have produced some pigs with whorls. It would appear from this analysis that boar 100 is heterozygous for one factor and boar 101 heterozygous for the other factor of the pair assumed to obtain in this hypothesis.

No Animals Homozygous for Whorls

It is not very probable that any of the experimental subjects used in further matings in this experiment, were homozygous for whorls (*W W W' W'*). In two litters, totaling 17 pigs, sow 22 mated to boar 17, both with whorls, produced 8 with whorls and 9 without. This is near the expected ratio if both parents were heterozygous for both factors. Sow 23, when mated to boar 37 produced only 2 pigs with whorls in a litter of 10, and when boar 37 was mated to his litter mates 32, 33, 34, and 35 they produced in one litter each a total of 35 pigs, 22 of which had whorls and 13 of which were smooth-haired. If any of these sows had been homozygous for whorls, obviously all of their progeny would have been manifesting whorls.

eliminated. When a smooth-haired boar mated to smooth-haired sows (that have not produced pigs with whorls to other boars), sires pigs with whorls, the boar is often given the entire credit for producing whorls. As a matter of fact, he is probably no more responsible than the sows that produce pigs with whorls. From the data presented it seems evident that it is impossible for a pig to have a whorl if only one parent carries the heritage for a whorl.

If the two-factor hypothesis assumed as an explanation for the heritage of whorls is correct, one can readily see why the inheritance that produces whorls is so generally distributed. A herd boar which carries one factor will transmit it at least to half his offspring. Subsequent herd boars may carry the same factor and repeat the performance of their predecessor, adding to the concentration of this factor in the herd. Whorls will not appear until the complementary factor is introduced, generally by a new boar. It is easy to see why he may get the entire credit for producing whorls.

The elimination may be even more difficult, if, as previously assumed, there are separate factors that determine the point of location of whorls on the backline. If then, the factors for whorls and for location are inherited separately, it seems to follow that even the two factors for whorls may be present without whorls being manifested. This is purely hypothetical. However, the data suggest this possibility.

The most practical procedure for eliminating whorls in swine is to discard from the breeding herd all sows, and most assuredly all boars, that have whorls. It is almost as important to remove with equal diligence all smooth-haired sows and boars that produce progeny with whorls. Obviously the factors have been handed down through at least one of each of the two paternal and maternal grand-parents but it will require carefully planned matings to determine which of these four carry the undesirable inheritance.

Summary

1. It appears that two dominant Mendelizing factors interact together to cause the appearance of whorls and these factors must be present in the heterozygous or homozygous condition before whorls are produced.

2. Causes of variation in location of whorls, and the procedure most rapidly to eliminate the defects are discussed.

Literature Cited

1. Brewster, E. T., 1925. The Inheritance of "Double Crown." *Journal of Heredity* 16, (9) : 345-346.

2. Craft, W. A., Breeding Studies in Swine. *Biennial Report, Oklahoma Agr. Exp. Station for* 1924 1926, p. 36.

3. Craft, W. A., Pigs Inherit Swirl Hair. *Report of Oklahoma A. & M. College Agr. Exp. Station,* 1926-1930, p. 86.

3a. Craft, W. A., 1931. The Inheritance of Hair Whorls. Oklahoma Academy of Science (in Press).

4. Eschricht, D. F., 1837. Uber die Richtung der Haare am menschlichen Körper. *Müeller's Archiv für Anatomie und Physiologie.*

5. Kidd, Walter, 1903. The Direction of Hair on Animals and Man; London: Adams and Charles Black.

6. Landauer, Walter, 1929. Die Vererburg Von Haar und Hautmerkmalen, ausschliefslich Farbung und Zeichnung II. Sonderabdruck aus der *Zeit. für indu. abs.-und Vererb.* 1929 Bd. 50 Heft 3/4.

7. Lauterbach, C. E., and Knight, J. B., 1927. Variation in Whorl of the Head Hair. *Journal of Heredity* 18 (3) : 107-115.

8. Nordby, Julius E., 1928. Whorls in the Hair of Swine, *Bulletin No. 164,* p. 18, Idaho Agricultural Experiment Station.

9. Nordby, Julius E., 1929. Whorls in the Hair of Swine, *Bulletin No. 160,* p. 21, Idaho Agricultural Experiment Station.

10. Pictet and Ferrero, 1929. Recherches sur la constitution genetique du Cobuye a rosettes. *Zeit. F. Ind. Abs. U. Vererb.* Vol. 52.

11. Van Herwerden, M. A., and Laughlin, H. H. Standard Pedigree Charts, *Journal of Heredity,* 1926, Vol. 17, No. 8.

12. Voight, C. A., 1856. Abhandlung Uber die Richtung der Haare am menschlichen Körper. *Denkschriften der Akademie d Wissenschaften zu Wien, Mathamatisch Naturewissenschaftlichle Classe,* Part II, 13: 1-50.

THREE VIEWS OF EVOLUTION

Recent Discussion of the Causes of Evolution, of the Present Status of Evolution Theory, and of Evolution of Human Behavior

VERERBUNGSLEHRE MIT BESONDERER BERUCKSICHTUNG DER ABSTAMMUNGSLEHRE UND DES MENSCHEN, *by* L. PLATE. Band I. Mendelismus. X+554 pp., 133 figures. Price, paper covered, 26 marks; bound, 28 marks. Jena, G. Fischer, 1932.

THIS is a second (revised) edition of a well known text book of heredity written by the successor of Ernst Haeckel at the University of Jena, who is also director of the unique Phyletic Museum of Jena. The first edition published in 1913 discussed with a thoroughness and exhaustiveness perhaps unequalled in writings of that period the bearing of the newer knowledge of heredity upon the evolution theory. The present edition brings this discussion up to date. A task so stupendous, in view of the enormous literature of genetics in the past twenty years, few would have had the courage to undertake. Plate not only undertook but has also accomplished the task with astonishing success,—assembling, classifying and assimilating all pertinent literature. Students of genetics are greatly indebted to him for this achievement. Most of us are so deeply engrossed in exploiting a particular aspect of the subject that we have little time or inclination to attempt a detached airplane view of the whole field. Geneticists, as a rule, have very little to say about evolution, yet it is chiefly in relation to this general subject that their studies give promise of lasting value. Plate emphasizes evolution as the central problem even in his discussion of Mendelism in the present first volume of a proposed three volume work, the subsequent volumes to deal with: II Sexuality and its problems and; III Special genetics of the most thoroughly investigated animals and of man.

His own basic ideas about evolution which of necessity influence his judgment of the value and significance of particular investigations, the author frankly communicates to the reader in his preface. They are substantially and as nearly as possible in his own words as follows:

1. Mutation has come to include a variety of concepts of different value in relation to evolution, as they differ in hereditary value. We may recognize the following gradation with increasing value in heredity: (a) somatic modifications not inherited; (b) weak mutations including persisting modifications; (c) labile mutations of intermediate races; (d) genuine mutations and changes in the heredity-basis (Erbstock).

2. Genes demonstrable by the method of crossing pertain only to varietal characteristics. In addition to them, it is necessary to assume the existence of a basis of heredity likewise contained in the nucleus (but not in the chromosomes, therefore not statistically demonstrable) which conditions the plan of organization found in genera, families and higher categories of classification.

3. Cell plasma as a basis of heredity is not to be accepted, if we understand thereby discrete parts of the cytoplasm with specific effects. But the physical-chemical constitution of the cytoplasm is of course of the greatest importance since the cytoplasm is the instrument through which the cell operates.

4. Goldschmidt's views advanced in his physiological theory of heredity are unacceptable, for genes are not enzymes but living bearers of energy which force the epigenetically changing cytoplasm to assume particular functions. Neither are genes to be confused with hormones. The different genes of a species and also the different alternative forms (allelels) of a gene are not

merely quantitatively but qualitatively different.

5. Functional adaptation is scarcely capable of explanation without the assumption of an inheritance of acquired characters. Such assumption is justified because as yet no convincing experimental evidence against it has been produced. No one as yet has for hundreds of generations enforced a particular kind of use or disuse and demonstrated a consequent inheritance or non-inheritance. Experimental proof and disproof are alike wanting, but there are hundreds of facts which without it are unintelligible. Lamarckism is therefore to a certain extent justified and is not at variance with the mutation theory since accidental mutations could through use be improved.

6. Progress in phylogeny is accomplished primarily by neo-mutations, that is through the development of entirely new genes either produced by the cytoplasm or originating spontaneously.

7. The theory of descent must in the future as in the past be based primarily on the results of comparative morphology (palaeontology, anatomy, embryology) and on the geographic distribution and life histories of organisms. Genetics is almost never in a position to disclose the genealogical connection between species, genera, and higher categories. But it does disclose the basis for species formation by explaining the mode of origin of varieties and races and the mutual infertility of divergent types.

8. Darwin's views still stand substantially correct; that is, selection plays an enormous rôle, as every geneticist daily observes. Evolution progresses over millions of corpses. In the origin of species small heritable differences are gradually summated so that varieties become races and races species. Darwin recognized quite correctly the cooperation of selectionist and Lamarckian factors although he also gave little consideration to the latter. Whoever speaks of a "crisis of Darwinism" shows only his own incapacity to survey the entire observational field and arrange all in a unified theoretical view.

There is no single topic in the entire field of Mendelism on which Plate has not assembled a superabundance of illustrative material, usually with a critical discussion of the evidence for or against particular hypotheses. The exhaustive topically classified bibliography will be especially useful to the student. An excellent index will allow instant reference to the investigationss of any particular author or on any particular subject or with any particular genetic material.

W. E. Castle.

Bussey Institution.

Evolution and Adaptation

In a book containing the wealth and diversity of information that is crowded into Caullery's *Le Problème de l'Evolution*,* it is difficult to find any few salient points that can justly be isolated for emphasis in a brief review. In this journal attention should perhaps be directed toward matters intimately related to heredity, although in attempting this the reviewer must hasten to state that genetic material comprises but a small fraction of the volume. There is an academic and uninteresting discussion of the origin of life, followed by an entertaining, and stimulating series of chapters dealing with palaeontology, appearance of animal groups, evolution of mammals, parallel evolution and convergence, morphology, rudimentary organs, parasitism, and geographical distribution. These rather hackneyed subjects are treated with a freshness and critical insight that makes the book pleasant reading In fact, it is such a book as graduate students and biologists in general, par-

*Caullary, M. Le Problème de l'Evolution. Pp. 447. Payot et Cie. Paris, 1931.

ticularly geneticists, well might read from time to time, merely for the sake of orientation.

Nine chapters comprising 236 pages are designed to set forth the "fact of evolution," which is done with no lack of interpretative discussion and critical comment. The remaining six chapters, spread over 193 pages, are concerned with the "mechanism of evolution," a subject in which the author concludes (one may infer) that we are still sadly ignorant. In the latter part of the book the treatment becomes somewhat historical, and this is probably as satisfactory a method as any for bringing out the views which have contributed to our present outlook.

Like several other leading French biologists, Caullery is much concerned with the question of adaptation, a problem which is of no small moment to the theoretical geneticist. Admitting freely that much which passes as adaptation might be explained in other ways, the author, nevertheless, accepts the phenomenon as a reality and recognizes four distinct viewpoints that have been entertained by those who would explain it.

Four Theories of Adaptation

1. Special Creation. One of the outstanding exponents of what is called "special creation" was Cuvier, who maintained that not only must the parts of each individual be in harmony, but all nature must be balanced, some species serving as prey and others as destroyers and regulators of propagation. One could not well imagine, says Cuvier, a world in which there were flies and no swallows or swallows and no flies. All this harmonious adaptation was in effect foreseen and prearranged. Caullery calls it "adaptation *a priori*."

2. A diametrically opposite view was introduced by Lamarck, who in 1809 (*Philosophie Zoologique*) made the following significant statement (translating freely): "Nature in the process of producing successively all the species of animals, beginning with the most imperfect or simplest and ending with the most perfect, has gradually made their organization more complex; and as these animals became disseminated through all the inhabitable parts of the globe, each species received through the influence of the circumstances in which it found itself, the characteristics and modifications with which we are familiar." This Caullery would call "adaptation *a posteriori*."

3. A third idea is that transformations, arising from whatever cause, endow certain individuals with special potentialities or qualities which result in their "filtering" into that environment for which chance has made them most suited. This is the "fortuitous preadaptation" of Cuénot (See "The Problem of Adaptation," JOURNAL OF HEREDITY, 18:125-131, March, 1927). A similar idea was foreshadowed by Buffon, who, after describing in great detail the wonderful adaptation of the woodpecker for its particular mode of life, went on to say that this bird "has received from nature organs and instruments appropriate to this (its) destiny or, better, it derives this very destiny from the organs with which it is born."

4. Finally there are others, including Rabaud (*Adaptation et Evolution*, 1922) who for the most part deny the reality of anything except direct physiological adaptation. True morphological adaptation, they would say, does not exist. These students regard the matter negatively: All variations may persist except those which are *too* noxious for their possessor.

Adaptation Still Unexplained

Without following through the elaborate analysis found in the text, we may say in short that nature presents us with a series of examples varying from those which are in fact rather poorly adapted to those which show a marvelous fitness for various special situations. These latter are not merely physiological but often definitely morphological, and in general are fully developed in advance of actual need. But a satisfactory explanation of them still

escapes us. The grades of adaptation are too varied and the evidence of evolution too overwhelming for us to consider seriously the special preordination of Cuvier. In all the years since Lamarck, no one has convinced the world of the hereditary transmission of any "acquired character." To attribute to blind chance some of the marvelously adaptations which we meet would appear to Caullery as näive and unscientific.

Development of the Theory of Evolution

It is a rather interesting idea that a necessary precursor for the theory of evolution was a concept of the species as a definite entity. Leaving aside philosophical speculations of the ancients, we may seek the foundations for modern evolutionary thought in the writings of John Ray who, in the seventeenth century, formulated the notion of species based on the similarity of individuals and the transmission of traits from generation to generation. After that came Linneaus and the dissemination of the species concept with its implied emphasis on exact hereditary transmission. Another fifty years for the thorough establishment of this viewpoint and Larmarck was ready to present his theory which centers around the two well known ideas: (1) Use of an organ or part increases, strengthens, and fortifies it, while disuse results in reduction or, indeed, complete atrophy. (2) Whatever nature has enabled the individual to acquire or lose tends to be transferred to the offspring where it may become a part of the common heritage of the descendants.

Lamarck is given credit for being unquestionably the first transformist. This entitles him to great honor which should not be completely dimmed by the fact that he was no match for Cuvier in an argument, that he was accused of reasoning in circles, or that Huxley made sport of him with his *"buccinator tantum."* The crux of Lamarckism is that species do, indeed, undergo evolutionary change and that the impetus for this change comes from within.

Later Darwin and Wallace came forward with their well known deductions, and gave us the evidence that evolution is directed from without. They were followed by the great popularizers, Huxley and Haeckel, and the development of that body of classical evolutionary theory which belongs to the latter part of the nineteenth century. Caullery comments that the idea of natural selection or survival of the fittest appealed to many as so obvious that proof seemed superfluous. One must seek long and carefully to find even a few good experiments designed to test the theory. Nevertheless, many lines of biological endeavor combine to create confidence in the reality of evolution.

Newer Theories

In the meantime a distinction between germplasm and soma was being emphasized by Weissmann and foundations were laid for genetics (Naudin is placed practically on a parity with Mendel by Caullery) and the mutation theory of de Vries. These developments have tended in a measure to undermine some of the older views. No longer can we think with Lamarck and Darwin of evolution in terms of adult structure. The adult, as such, has nothing to contribute. Only the germ cell in which the adult is, in a sense, preformed, holds the key to ontogeny, to morphology, to adaptation, and to all the gross features which biologists have been studying in the past. We find ourselves at last confronted with the problem of the evolution of egg cells which still seem to differ little from each other except in their developmental potentialities.

Naturally the elaboration of this picture calls for review of the work of many students—of Bateson's famous British Association address, and of the newer, special theories of Lotsy, Rosa, Przibram, and many others. None of them are found to be satisfactory, and ever recurring is the implication that

the main blocks for the structure we would build are still lacking.

Relation of Genetics to Evolution

In some respects it is Caullery's treatment of genetics that to many will seem weakest. For example, in discussing dominance, no reference is found to Fisher; and in the matter of genetic analysis of wild species, there is nothing relating to the studies on Crepis (Babcock et al), or other comparable work. Allusions to similar deficiencies could be multiplied, but there are plenty of interesting comments which genetists may weil consider.

Genetics, we are told, is a "laboratory subject" and its conclusions apply only in the laboratory field. The very controlled conditions which are imposed make improbable any results of evolutionary significance. Genetics leaves adaptation "wholly unexplained." Genetics, it is said, does not produce new species. Closely related species generally differ from each other quantitatively in many minor respects and are mutually sterile, while genetic races differ qualitatively in a few or many respects but are not sterile. For example, the most diversified strains of *Drosophila melanogaster* seem to differ far more than do many wild species but there is no sterility and no doubt as to the specific unity—a new species has not been created. If one does not agree with all these sentiments he may at least find them worth considering.

The Real Problem

When we review the whole field, we find ourselves confronted with an enigma. It seems certain that evolution has taken place, and we see factors that might have contributed to the process, but we know of nothing that is adequate to explain it. Adaptation is in large measure a matter of adult structure, yet its basis lies in the egg, and we know of no way in which the physiological adaptation of the individual can be transmitted to the germ cells. Finally, species are not, as Darwin and others thought, in a state of flux; they are essentially stationary — "genetics shows that." Might it not be, we are asked, that species and groups pass through periods of plasticity during which new species are rapidly evolved, and then relapse into a state of relative fixity when mutations result in changes of no evolutionary significance whatever? Among all the Carnivors in the world today, none appears to be in process of becoming a cetacean; and yet, there is abundant reason to believe that once in the history of animal life, this feat was accomplished. Among questions such as these, Professor Caullery leaves his reader to reflect on the problem of evolution. The reviewer suspects that few will read this book without feeling anew that most of the great biological discoveries are still in the future.

C. H. DANFORTH

Stanford University.

How We Get That Way

THE EVOLUTION OF HUMAN BEHAVIOR, *by* CARL C. WARDEN, Assistant Professor of Psychology, Columbia University. Pp. 248. Price, $3.00. The Macmillan Co., New York, 1931.

THE majority of books on evolution have dealt, as the author of the present volume points out, more with anatomical changes than with behavior. ". . . . the evolution of human intelligence, with its almost limitless capacity for cultural development, should be regarded as the central theme of the general problem. The facts of structural evolution must find their larger meaning in terms of the cultural evolution which they have made possible.

The psychological approach, growing out of this conception, offers a new orientation in interpreting the biological and sociological factors involved. The present treatment is as non-technical as could well be without sacrificing something of scientific accuracy."

In two hundred and fifty pages Professor Warden has sketched a broad background of the morphological data supporting organic evolution against which he has logically drawn in figures of historic man with his changing possibilities. It is inevitable that morphological details take up more of the book than the title might suggest, but nevertheless, I know of no one book that touches on so many different aspects of human evolution. The author has condensed into his pages the results of his readings in many fields—a summarization that perhaps makes these pages just a bit difficult to read, clearly written though the text is.

The scope of the book is indicated in the chapter titles: I. Some problems of human evolution, II. The natural kinship of man and animal, III. When anthropoid became human, IV. Traces of early man, V. The coming of modern man, VI. Race and civilization, VII. Present trends in evolution.

The entire treatment is logically mechanistic even to speculation on the origin of life itself which undoubtedly will strike fire in quarters that are usually given to burning up on such issues. It is not my opinion that the book is as popularly written as the writer hoped or as scientific necessity would permit, but nevertheless the story is presented in a thorough and scholarly fashion and is well worthy of consideration as a text or as outside reading in any course in organic evolution.

ROBERT T. HANCE.

University of Pittsburgh.

Science Interpreted

SCIENCE TODAY AND TOMORROW. Compiled from a series of lectures delivered at Moreley College. Pp. 196. London: Williams and Norgate, Ltd., 1932.

The object of the lectures on which this volume is based was to give the audiences of working men and women an outline of the progress recently made in each of the principal fields of science. Consequently the subjects are treated in as simple and non-technical a manner as is possible in matters leading to the uttermost limits of human knowledge. The lecturers included some of the most distinguished British scientists. The chapter on astronomy is by Sir Frank Dyson, the Astronomer Royal; that on psychology by Dr. Emanuel Miller; while Professor F. G. Donnan discusses recent discoveries in chemistry and radiation; Professor G. Elliot Smith, in the chapter on anthropology, elaborates his much-discussed views regarding the origin and dissemination of civilization, looking to Egypt as the cradle of the agriculture, invention and pictorial art which later diffused throughout both eastern and western hemispheres. The chapter on medicine, its present development and possibilities, by Dr. Jane Walker, likewise has much interest to the geneticist, as has also Joseph Needham's discussion of some of the present problems in biology, including particularly his analysis of the laws of growth. To many readers the foundation of scientific rationalization — mechanism — will prove the most stimulating chapter of the book, while others will find interest and enlightenment in Sir Arthur Hill's chapter on botany or Professor W. T. Gordon's lecture on geology.

The mastery of the contents of this little volume will give the reader an up-to-date view of some of the more important problems in the sciences which many of the best minds of our day are struggling to solve.

W. R. COE.

Yale University.

DOUBLE FLOWERS AND MULTIPLE FRUITS OF THE JAPANESE APRICOT*

CLAYTON O. SMITH
Riverside, California

THE Japanese apricot (*Prunus mume,* Sieb and Zucc.), is one of the desirable ornamental trees of Japan. Although selected seedlings have been distributed by the United States Department of Agriculture, and have been advertised and sold by many nurserymen of California, their planting in the state is not extensive.

Two chance seedlings of this species have been under observation for some years at the Citrus Experiment Station. They were grown in an experimental planting from seed imported about 1919 by the United States Department of Agriculture. These seedlings have large fragrant double flowers. One has white and the other reddish purple blossoms.

It is worthy of note that the double flowers of these two varieties should often also have multiple fruits, several fruits originating from an individual flower. This characteristic was not observed in other double or single flowering trees of this species, and can not be regarded as associated necessarily with double flowers. These fruits are of uniform size, normal shape, have kernels with well developed embryos, and are produced in groups of one to four from an individual flower. Sometimes as many as five rudimentary fruits are formed, but some of these are probably unfertilized and become abortive. The fruits are individual carpels and each has its own attachment to the stem. They are not coalesced as is usually the case with twin fruits of almonds, peaches and plums.

Figures 7 shows different ages, sizes, and the smaller abortive fruits. Different counts of a number of fruit clusters developing from individual flowers were made on the reddish purple flowering variety, and in 100 counts showed the following:

47 flowers had 1 fruit
43 flowers had 2 fruits
9 flowers had 3 fruits
1 flower had 4 fruits

The counts made on the white double flowering variety were in close agreement with these results: of 81 fruits, 41 were single, 31 double, and 9 triple.

The white flowering variety (Figure 6, lower) was in bloom January 15, 1932, at a time when flowering shrubs in California were rare. The tree is about 12 feet high with a spread of 8 feet. The shoots are thickly covered with roselike flowers. These are about an inch in diameter, white, fragrant, double, with three rows of petals, and numerous stamens. The bloom does not appear all at once, so the tree may be in flower for some time. The length of the blooming period depends much upon weather conditions. When in full flower the tree is a mass of white, and is agreeably fragrant.

The reddish purple flowering variety (Figure 6, upper) is much like the white one except for the color, the later appearance, and the smaller size of bloom, which is about three-quarters to an inch in diameter. The petals form several circles about the numerous stamens and are a reddish purple (pansy purple, Ridgeway†). The calyx lobes are frequently six in number instead of the typical five (see Figure 7). The flowers appeared February 15, 1932. The bark of the

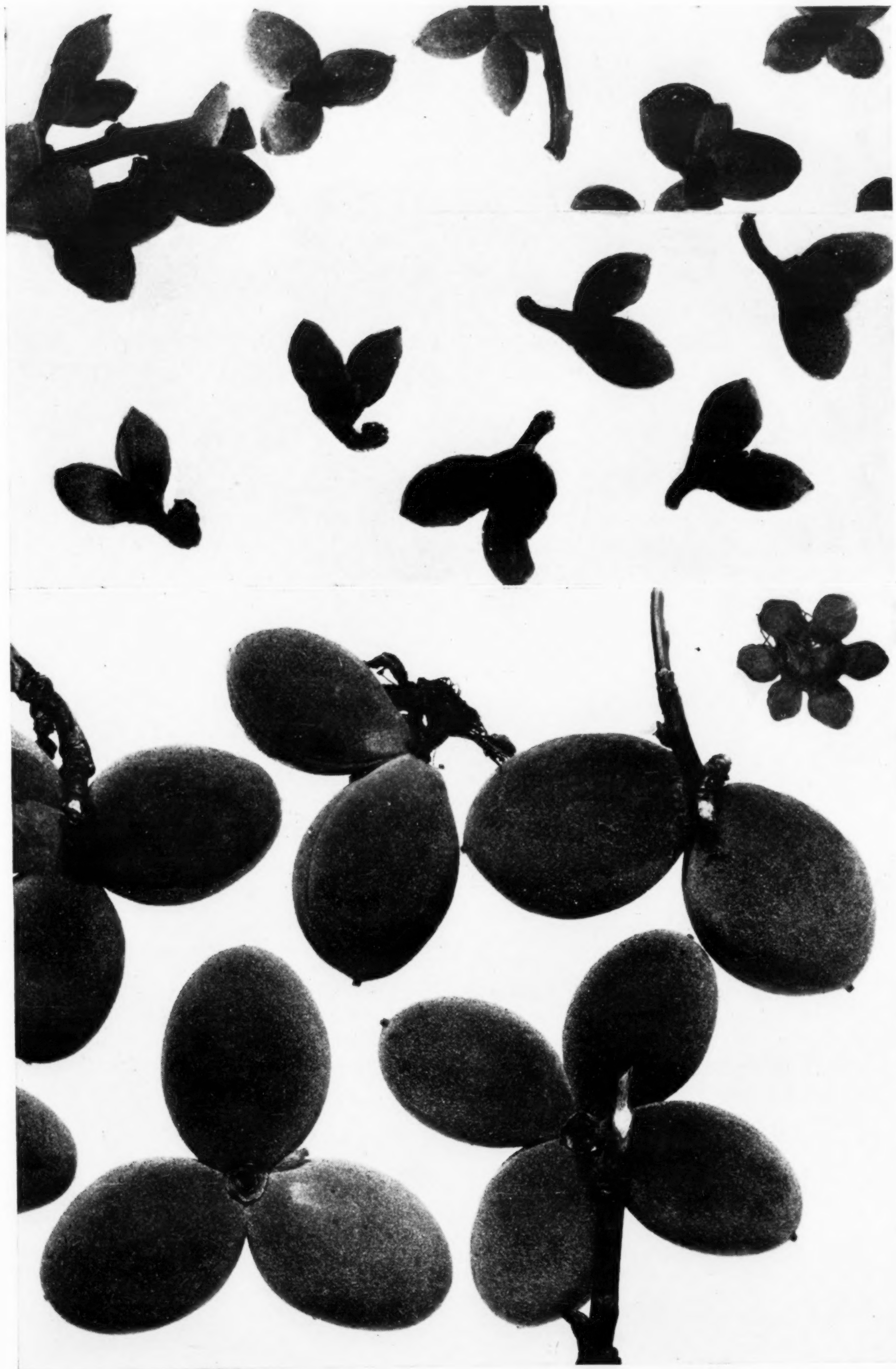
*Paper No. 272, University of California Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

†All color references are to RIDGEWAY, ROBERT. Color Standards and Color Nomenclature. Washington, D. C., 1912.

DOUBLE FLOWERS OF JAPANESE APRICOT

Figure 6

Two chance seedlings of *Prunus mume* are of interest because of the production of double flowers and multiple fruits. The white-flowered seedling flowers a month earlier than the pink-flowered (above).



MULTIPLE FRUITS FROM DOUBLE FLOWERS

Figure 7

Two stages in the development of multiple fruits from the double-flowered apricots shown in Figure 6. Other double-flowered forms of this species have not been observed to have multiple fruits. What the relation is between the two characteristics has not been determined. The six-lobed calyx often found in the pink flowered form is shown at the right.

young growth is reddish purple to dark perilla purple. The older bark and the cut surface of the older wood has a purple color, but the wood of the young shoots may be white. The bark of the young growth of the white flowering variety is light green to lettuce green, and on parts exposed to the sun it is reddish purple. The reddish purple variety, which is about eight feet high, is more dwarfed than the white variety. The flowers are fragrant, but possibly not so fragrant as those of the white variety.

The important characteristics of the white variety are its early season of flowering, and the large size of flower and tree. The purple flowers of the other variety are interesting and the smaller size of the tree is more suited to some landscape uses.

Books Received

BOOKS are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the JOURNAL *will be reviewed in later numbers.*

EMIGRATION, MIGRATION AND NOMADISM, *by the late* WALTER HEAPE, M. A., F. R. S., Edited with a Preface *by* F. H. A. MARSHALL, Sc. D., F. R. S. Pp. 369. Eleven Chapters. Price 12s 6d net. W. Heffer & Sons, Ltd., Cambridge, England. 1931.

COMMON SENSE AND THE CHILD, *by* ETHEL MANNIN. Pp. 314. 20 Chapters. Price, $2.00. J. B. Lippincott Co., Philadelphia. 1932.

Mrs. Mannin evidently had a very repressed early environment. As a result her Declaration of Independence for children leans amply far the other way. After all, Man *is* a social creature, and one wonders (without being sure) just how the implications of this fact are to be inculcated without undue restriction of child-personality. The book has many excellent points.

THE SCIENTIFIC BASIS OF EVOLUTION, *by* THOMAS HUNT MORGAN, Director of Kerckhoff Laboratories, California Institute of Technology. Price, $3.50 New York, W. W. Norton & Co. 1932.

When we strip evolution of all theories, hypotheses and wild guesses, and confine ourselves to demonstrated facts and legitimate implications from these, as Dr. Morgan has done, genetics has progressed far enough to afford material for a most interesting and inspiring book.

WILL IT BE A BOY? Sex-Determination According to Superstition and to Science. *By* DR. F. OKLAND, Assistant Professor, Aas. Norway. 15 Illustrations. Pp. 116. Price, $1.50. The Century Co., New York. 1932.

Superstitions of sex-determination exploded and the chromosome mechanism discussed, with speculations on the possibility of influencing the sex-ratio.

CHROMOSOMES AND PLANT-BREEDING. *By* C. D. DARLINGTON, Ph. D., D.Sc., Cytologist, John Innes Horticultural Institution. Pp. 112. 25 Illustrations. 17 Chapters. Price. $1.75. The Macmillan Co., New York. 1932.

Recent co-advances in cytology and genetics make the art and science of plant improvement more interesting, perhaps more fruitful, but hardly more outwardly simple than former casual methods of plant breeders.

PROSPECTING FOR HEAVEN: Some Conversations about Science and the Good Life. *By* EDWIN R. EMBREE, Director of the Rosenwald Foundation. Pp. 185. The Viking Press, New York. 1932.

Science has been hard on Elysian Fields; can it find a heaven this side the stratosphere?

HERITABLE CHARACTERS IN MAIZE

XLIII—Zebra Seedlings

H. K. HAYES*
University of Minnesota

ZEBRA seedlings first appeared in 1924 as segregates in a first year selfed line of Longfellow yellow flint. Selfed zebras were grown again in 1925 and in 1929 crosses were made with various linkage testers. It received its name because of its close resemblance to zebra plant described by Demerec.[1] Zebra seedlings when grown to maturity and selfed bred true for the character.

Unlike zebra plants, the seedling character can be separated easily from normal in the seedling stage. The best idea of the character can be gained from an examination of the photograph (see Figure 8). The characteristic appearance consists of somewhat irregular chlorotic cross bands which appear on the leaves when the seedling has reached the two or three leaf stage. Before the plant reaches maturity the characteristic zebra banding disappears entirely. Zebra seedlings are somewhat less vigorous than normal seedlings in the same culture.

Segregating progenies were grown in sand during the winter of 1930-31 at University Farm, St. Paul. One group of progenies was grown in sand in a warm greenhouse where the air temperatures averaged between 70 to 75°F. and the variation in temperature was rather great. The seedlings were watered with a nutrient solution when about in the three leaf stage. Segregation occurred in a ratio of 414 normal to 119 zebra and the germination percentage was 96.6. The deviation from a 3:1 ratio is 14.3 ± 6.7. It is suggested that the factor symbol zb_s be used to represent the character.

Another similar group of F_2 crosses was grown in flats in a greenhouse where the soil temperature approximated about 60°F. The temperature was kept relatively constant by means of thermostatic control and deviated no more than ± 2° from this average. Although this group of progenies remained under these conditions until the four-leaf stage and were carefully examined no zebra seedlings appeared. The seedlings which were grown until about the four-leaf stage under a constant soil temperature of 60°F., without any evidence of the appearance of the zebra character, were taken to the warmer house and watered with a nutrient solution. After about a week the characteristic zebra appearance could be detected and at the end of about a 10-day period there was a ratio of 347 normal to 100 zebra. The deviation from a 3:1 ratio is 11.8 ± 6.1.

The results during the winter of 1930-31 made it seem probable that growing seedlings under conditions where they developed favorably would lead to the expression of the zebra seedling character. Several zebra plants were self-pollinated during the summer of 1931. Only a small amount of seed was obtained. This is to be explained as being a result of the severe drought, rather than indicating a lack of fertility due to the zebra seedling character. Seed of the progenies of selfed zebras and of a further series of F_2 progenies of zebra crosses was sown in soil in a house where the temperature was controlled. A soil temperature of approximately 60°F. was used until the plants were about

---

* Chief, Division of Agronomy and Plant Genetics, University Farm. Mr. R. F. Peterson, Research Assistant, gave efficient aid in the studies here reported. Paper No. 1098 of the Journal Series, Minnesota Agricultural Experiment Station.

†DEMEREC, M. Heritable characters of maize—X. Zebra striped leaves. JOURNAL OF HEREDITY 12: 406-407. 1921.

six inches high and at this time warmer temperatures were used. The seedlings were grown close together and artificial lights were turned on from 12 p. m. until morning. No clear cut segregation of zebras was obtained and while a slight tendency to develop the character was noted the differences between zebra seedlings and normal did not make it possible to classify the seedlings accurately. This led to a careful study of the conditions necessary for the development of zebra seedlings.

Temperature Effect on Development of Zebra Seedlings

Selfed progeny of a homozygous zebra seedling plant were used to study the conditions necessary for the development of the zebra seedling character. In the first study carried out, seedlings were planted in separate flats both in sterilized and unsteamed soil and in sterilized and unsteamed sand. Seed, used for a part of the flats, was treated with Semesan Jr. which is known to aid in protecting the seed from diseases which cause seedling blight. As sterilization of the soil and seed treatment with Semesan Jr. had no affect on the development of zebra seedlings, no further reference will be made to these phases. In the first study of conditions necessary for the development of zebra seedlings, two groups of tests referred to as *A* and *B* were carried out:

A. Seed was sown on Nov. 24 and emergence occurred on Nov. 29. The following approximate air temperatures were maintained: Nov. 24-Dec. 6, 86° F; Dec. 7-14, 71° F; Dec. 15-19, 64° F; Dec. 20-22, 77° F. The houses were under thermostatic control which maintains soil temperatures with a fluctuation of about ± 2°F.

B. Seed was sown on Nov. 24 and emergence took place on Dec. 3. Temperatures maintained: Nov. 24-Dec. 6, 70°F.; Dec. 7-14, 71°F.; Dec. 15-19, 64°; Dec. 20-22, 77°.

Seedlings in trial *A* grew rather spindly as a result of the high temperatures during the early period from Nov. 24-Dec. 6. Because of this condition the seedlings grown by the method described under *B* were somewhat more satisfactory. It will be noted that trials *A* and *B* differed only in that high temperatures were used during the early period from Nov. 24 to Dec. 6 in series *A* and moderate temperature in test *B*. In both trials the characteristic zebra appearance of the seedling leaves was obtained during the final period from Dec. 20-22. The period of low temperatures, Dec. 15-19, caused a retardation in the development of the seedlings. The more rapid growth occurring during the period from Dec. 20-22 led to the development of the characteristic zebra appearance.

A second trial was made under the conditions given in Table I.

Seedlings in the *A, B, C* and *E* trials were in the three leaf stage on Jan. 5. Thre was no sign of the zebra character. Zebras appeared about Jan. 9 in trials *B* and *C* but not in *A* and *E*. This proves conclusively that constant high temperatures, trial *A,* do not lead to the development of zebra seedlings. Zebras do not develop when the seedlings are started under high temperaturs and then grown under constant low temperatures (trial *E*). Plants in *D* and *G* were in the one-leaf stage Jan. 5 while those in *F* had emerged but no leaves had developed. In trials *B* and *C,* zebras developed, proving that moderate to high air temperatures for the greater part of the time with a 24 or 48 hour period under colder temperatures, 52-54°F., and a return to the higher temperatures was conducive to the development of the zebra apparance.

A further trial was made to determine with a greater degree of accuracy the most desirable method of growing zebra seedlings under greenhouse conditions.

Progeny of homozygous zebra plants were grown in the greenhouse with an average air temperature of 82°F. Beginning on Feb. 29, when all plants were in the three-leaf stage, the seedling plants were exposed to the temperatures given in Table II.

The plants under the constant temperature, trial *A*, appeared normal but

ZEBRA SEEDLING COMPARED WITH NORMAL

Figure 8

Zebra seedling at left and normal at right from the F_2 generation of a cross between zebra and normal. These seedlings were selected to give an idea of the average vigor of the two groups of seedlings. The zebra banding appears only under certain environmental conditions.

indistinct zebra stripes could be found on all seedlings. The seedlings in tests *B*, *C* and *D* were all clearly zebras. The stripes were clearest in test *D* but *B* and *C* were quite satisfactory.

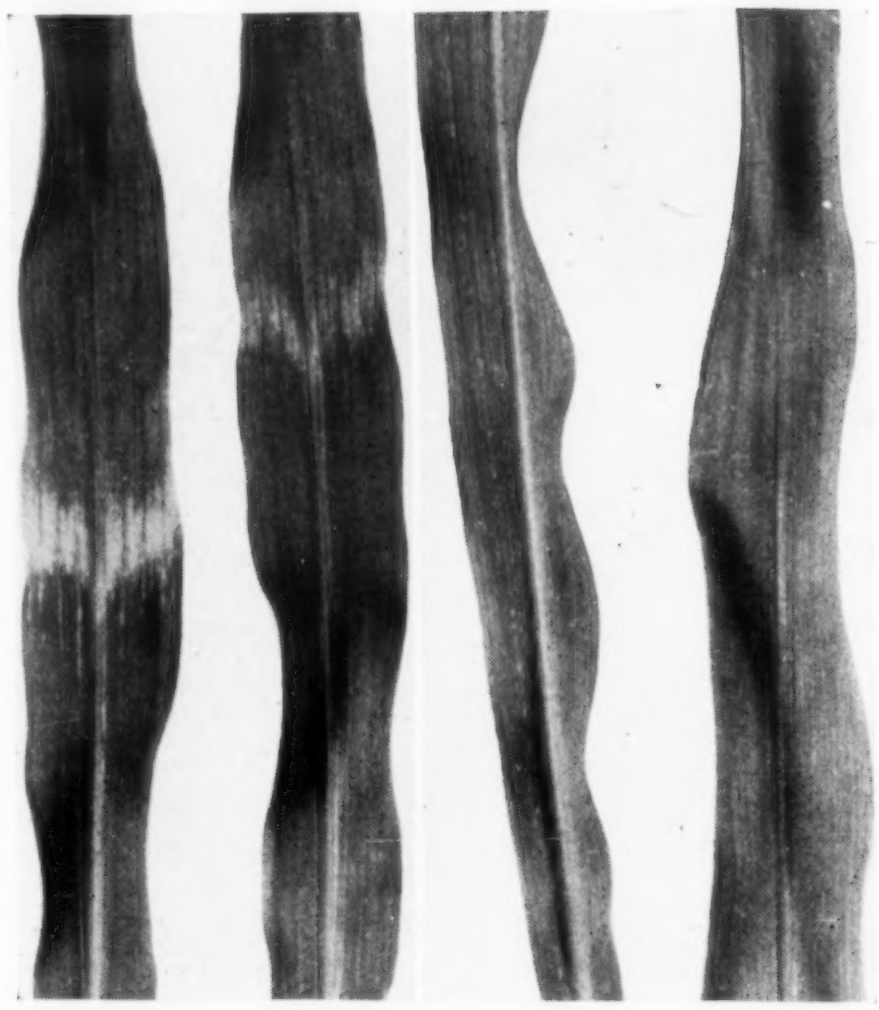
In another comparison the progeny of selfed zebra plants were grown in air temperatures of approximately 75° until the three-leaf stage. At this time four plants were placed for two days in a greenhouse with air temperatures of approximately 55°F. and then returned to the temperature of 75°F., for a period of five days and compared with seedlings, used as controls, remaining constantly under the temperature of 75°F. The seedlings grown for controls remained normal, the four treated plants, two days under 55°F., showed distinct stripes as illustrated in Figure 9.

Linkage Relations

When a homozygous zebra plant from the Longfellow variety was crossed with *Pr* tester the resultant

seeds were all purple aleurone proving the fact that the zebra seedling carried *Pr* in a dominant condition. When crossed with the *A* tester purple seed was obtained also while the cross with the *R* tester gave colorless seed. The results of linkage studies of zebra seedling and six other factor pairs in known chromosome groups are summarized in Table III.

Linkage studies were made with *A*, *Pr* and *R* in the cross between H194, zebra seedling, colorless aleurone and H6, *A* tester. The product method (Immer, 1930)* was used. The ears segregated for colored *vs* colorless aleurone and the color of the aleurone was of two sorts, purple and red. The cross was in the repulsion phase in relation to the *Prpr* factor pair, segregation for purple *vs* red aleurone and zebra *vs* normal seedlings occurring in the ratio of 255 purple aleurone, normal seedlings : 92 red aleurone, normal : 72 purple aleurone, zebra : 27 red aleurone, zebra. The calculated percentage of new combinations by the product method was 50.5 ± 2.4. This indicates that the *Pr* factor is inherited independently of the zebra seedling character. Segregation for aleurone color and normal *vs* zebra seedlings occurred in the cross H194 × H6, described in the previous paragraph. These results were obtained: 449 colored aleurone, normal seedlings; 382 colorless aleurone, normal seedlings; 140 colored aleurone, zebra seedlings; 97 colorless aleurone, zebra seedlings. The segregation for aleurone color obtained was 639 colored : 479 colorless. This is a deviation from a 9:7 ratio of 10.1 ± 11.3. Apparently segregation for aleurone color is dependent in this cross on two complimentary factors which in this case must be *A* and *R*. The linkage relations between Zb_szb_s and *Aa* could be studied in the repulsion phase and that between Zb_szb_s and *Rr* in the coupling phase. The product method was used. For repulsion, i.e. with the *Aa* factor pair the percentage of new combinations was 47.5 ± 2.4 and for coupling in relation to the *Rr* factor pair the percentage of new combinations was 52.5 ± 2.2.



LEAVES FROM PLANTS RAISED UNDER DIFFERENT CONDITIONS

Figure 9

At left, leaves of seedlings, in a homozygous zebra line, grown under a constant air temperature of approximately 75°F. until the three leaf stage, then placed for two days in an air temperature of 55°F. and then returned to the former condition. At right, leaves of seedlings kept constantly under an air temperature of approximately 75°F.

Studies were made of linkage relations of Zb_szb_s, with *Lglg*, liguleless; *Flfl*, flinty *vs* floury; and *Yy*, yellow *vs* colorless endosperm. The percentage of new combinations in these crosses is given in Table III. None of these characters appear to be linked in inheritance with zebra seedlings.

Summary

1. Zebra seedling (zb_s) behaves as a simple recessive to normal. The characteristic irregular cross bands appear on the leaves when the seedlings reach the two or three-leaf stage. Before reaching maturity this "zebra" banding disappears entirely.
2. Homozygous zebra corn seedlings

*Immer, F. R. Formulae for Calculating Linkage Intensities. *Genetics* 15: 81-98. 1930.

grown in a greenhouse with fairly uniform temperatures either show no zebra stripes or these are very indistinct. If seedlings at about the three-leaf stage are subjected to a temperature of 55 to 60°F. for one or two days and then placed under higher temperatures for a few days (70 to 85°) the stripes become distinct in from one to several days. Repeating the treatment seems to make the stripes plainer.

3. Under field conditions in Minnesota there appears to be sufficient variation in temperature so that the character can be differentiated easily.
4. From a study of F_2 segregating populations, zebra appears to be inherited independently from the aleurone color factors, *Prpr*, *Rr* and *Aa*. It was inherited independently also of the factor pairs *Yy*, *Flfl* and *Lglg*.

TABLE I.—Duration of time and air temperatures, Fahrenheit, under which the tests of the development of zebra seedlings were conducted.

Test	No. of Seedlings	Air Temperatures, Degrees F			
		Dec. 28-Jan. 5	Jan. 5-6 24 hours	Jan. 6-7 24 hours	Jan. 7-11
A	4	80-84	80-83	79-83	73-84
B	2	"	52-54	79-83	73-84
C	2	"	"	52-54	"
D	2	46-63	58-61	58-62	73-84
E	2	80-84	52-54	52-54	50-54
F	2	52-55	52-54	52-54	50-54
G	2	46-63	58-61	58-62	About 60

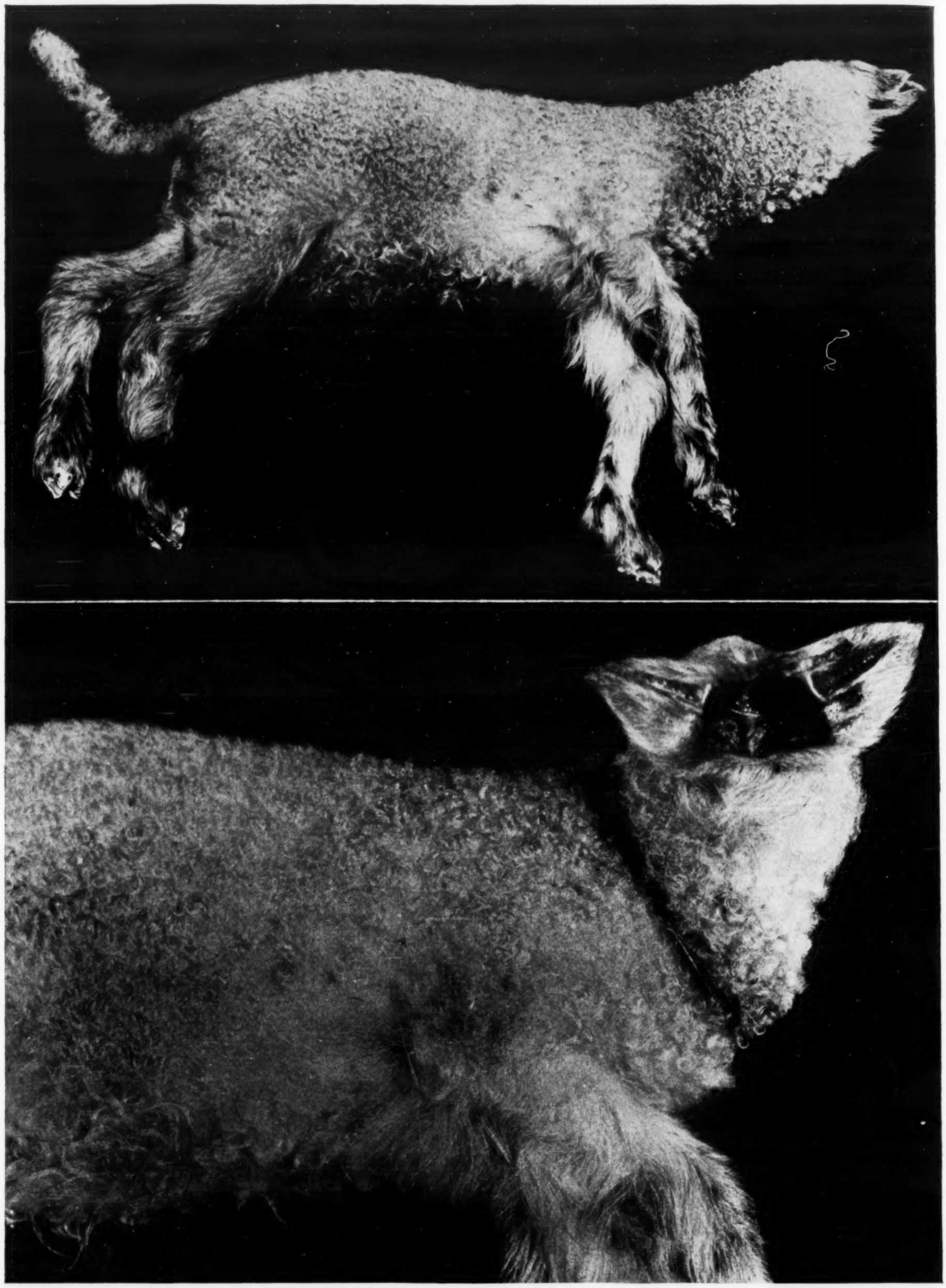
TABLE II.—Temperature conditions in a series of trials with the selfed progeny of homozygous zebras. Seedlings were in the three leaf stage at the time the trial was started.

Test	No. of Plants	Average Air Temperatures, F., each column represents 1 day						
A	7	72	72	72	72	72	72	72
B	6	55	72	55	72	55	72	72
C	6	55	55	72	72	72	72	72
D	6	55	55	72	72	55	55	72

TABLE III. Percentage of new combinations in the F_2 of crosses between Zb_szb_s and *Prpr*, *Aa*, *Rr*, *Yy*, *Flfl* and *Lglg*.

Phase	Factor Pair	Number of Individuals				Recomb. %
		AB[1]	Ab	aB	ab	
F_2 repulsion	Prpr	255	92	72	27	50.5 ± 2.4
"	Aa	499	382	140	97	47.5 ± 2.4
F_2 coupling	Rr	499	382	140	97	52.5 ± 2.2
F_2 repulsion	Yy	596	178	154	38	47.3 ± 1.7
"	Flfl	403	371	97	93	50.8 ± 1.6
"	Lglg	351	119	115	32	52.8 ± 2.0

[1]*A* and *a* represent normal and zebra seedling while *B* and *b* represent the other factor pair concerned.



A HEADLESS LAMB

Figure 10

Side view of lamb, showing general appearance, and a closer view of the fore part, showing small papillae in the depressed region between the ears where head ordinarily develops.

A HEADLESS LAMB

NATHAN FASTEN
Professor of Zoology, Oregon State College

RECENTLY one of my students brought in a lamb, of male sex, born on his father's farm at Cottage Grove, Oregon, on the evening of March 26, 1932, which appeared to be perfect in all respects with the exception that it did not contain any head. (Figure 10). On questioning the student, I learned that he was present when the monstrosity was born. The ewe which gave birth to it was in labor for a long period, practically the entire day, and when the lamb finally made its appearance, it was stillborn. The afterbirth appeared to be normal in all respects. Moreover, the lamb itself was of normal size, being approximately seventeen inches in length from ears to tail and about eleven inches in height. With the exception of being minus a head, the animal seemed to possess all of the other structures of a normal individual.

The ram which sired this headless lamb was a registered purebred Shropshire, while the ewe which gave birth to it was the product of a cross between the Shropshire and Cotswold breeds of sheep. On a previous occasion, this ewe gave birth to twins and these were normal in every respect. An external examination of the monstrosity revealed that where the head is ordinarily found, extending forward between the ears, there existed a series of small papillae. (Figure 10). No openings of any character, such as mouth and nostrils could be discovered. What an internal examination will reveal cannot be stated at this time. The specimen has been preserved for future examination and study.

A COLOR-MOSAIC IN THE MOUSE

A Mutational Mosaic (Brown-dilute Brown) Coat Pattern in a Mouse

JOHN J. BITTNER
Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine

THE number of mosaic individuals which has been recorded in mammalian genetics has been very small.

Several articles have been published on such results on Drosophila data. A few which may be mentioned are: Morgan and Bridges[8], Muller[9], and Morgan, Bridges and Sturtevant[8].

Castle[1] reported on the occurrence of a female guinea-pig which resembled an albino but had spots of blue. Faint pigmented streaks could be seen in the iris of each eye. He explained the phenomena, also a tricolor rat[2], as probably being due to non-disjunction.

Seven mosaic guinea-pigs have been described by Wright and Eaton.[11] Of

this number six were purely somatic in nature; whereas, the seventh showed the characteristic in part of the germinal tissue, as well as in the coat pattern.

Pincus[10] has described three mice which had black-brown coat patterns. The chocolate areas in two of the individuals showed up in positions which were normally white in the piebald strain. Another mosaic mouse has been described by Fisher,[5] tricolor in nature, as probably the result of a somatic mutation.

Castle[3] has also reported on tricolor rabbits: some of the progeny showed the mosaic pattern.

Material

We have raised a large number of F_1 individuals by mating mice of our albino and dilute brown stocks, both highly inbred. These animals are brown in color, as the albino race carry brown. In a litter in the 1BC generation (F_1 ♂ 8556 × dilute brown ♀ 8267) I noticed one animal (♂ 16643) which was a mosaic.

The dorsal surface of this male was brownish in color, whereas the ventral surface was more like a dilute brown. The respective areas were atypical as each had hairs of the opposite type scattered in a heterogeneous manner. There were no spots, characteristic of other mosaics. The distribution of the brown and dilute brown hairs has remained the same since birth (May 28, 1931).

Microscopic examination of the hairs showed characteristic pigment arrangement for both brown and dilute brown colors in the respective areas.

Results

Mosaic ♂ 16643 has been mated to a number of females. The progeny are listed in Table I.

All the young, 60, which were classified by mating ♂ 16643 to dilute brown females were dilute brown in color. Thirty-five young were raised by heterozygous brown females. Of this number, 17 were dilute and 18 intense brown; a typical 1:1 ratio.

Discussion

The theory of somatic mutation will explain the majority of the mosaic mammals reported.

There are a few exceptional cases, however. Wright and Eaton[11] explained the mosaic guinea-pig (♂ No. 8400) by assuming that it "was initially c^dc^d but that a mutation to the dominant allelomorph C occurred in a cell which was ancestral both to part of the soma and part of the germinal epithelium." This male transmitted both intense and dilute gametes, the proportion of each varying from time to time, but none of the progeny showed the mosaic pattern.

Pincus[10] states that somatic non-disjunction will explain the black-brown color patterns he encountered in three of his mice. He believes, however, that it is improbable that two of the three animals would show identical spots in the area which he designated "critical for pigmentation" according to this theory. In this region, which is usually white in piebald mice, "a recessive gene may exercise a controlling effect."

The mosaic pattern which Castle[3] described in the rabbit was also present in from three to four per cent of the offspring. Thus, the condition was germinal, and might be explained in accordance with the genomere theory of Eyster.[4]

Since the animal we found does not transmit brown, the theory of non-disjunction or somatic mutation is adequate as an explanation. To be sure, it is impossible to state whether the individual was initially a heterozygous brown which lost this factor from part of the soma and the germinal tissue, or a dilute brown. In the latter case, a mutation to the intense condition has taken place in part of the somatic tissue.

Castle[2] and Wright and Eaton[11] concluded that if somatic mutation had occurred in their mosaic patterns, the descendants of the mutant cells were capable of giving rise to scattered areas. In the case of our character, brown and

dilute brown hairs were scattered throughout the fur, with the former dominating on the dorsal surface and the latter on the ventral surface.

Summary

A mosaic male sired only dilute brown young when mated to dilute brown females and gave a 1: 1 ratio when mated to heterozygous brown females. Since mosaic does not transmit brown, it is probable that the brown pigment in the pelage is due to non-disjunction, or somatic mutation.

Literature Cited

1. CASTLE, W. E., On the origin of a pink-eyed guinea-pig with colored coat. *Science* n. s., 35:508-510. 1912.

2. ————————, On a non-transmissable tricolor variation in rats. *Carnegie Inst. Washington Publ.* 320, Part 2, pp. 51-54. 1922.

3. ————————, A mosaic (intense-dilute) coat pattern in the rabbit. *Jour. Exp. Zool.* 52:471-480. 1929.

4. EYSTER, W. H., The mechanism of variegations. *Verhn. d. V. Inter. Kong. f. Vererb.* Band 1, pp. 666-686. 1928.

5. FISHER, R. A., Notes on a tri-colour (mosaic) mouse. *Jour. Genetics* 23:77-81. 1930.

6. MOHR, O. L., A somatic mutation in the singed locus of the X-chromosome in Drosophila melanogaster. *Hereditas* 4:142-160. 1923.

7. MORGAN, T. H., and BRIDGES, C. B., The origin of gynandromorphs. *Carnegie Inst. Washington Publ.* 278:1-123. 1919.

8. MORGAN, T. H., BRIDGES, C. B., and STURTEVANT, A. H., The genetics of Drosophila. *Bibliographia Genetica* II, 262 pages. 1925.

9. MULLER, H. J., Further changes in the white-eye series of Drosophila and their bearings on the manner of occurrence of mutation. *Jour. Exp. Zool.* 31:443-472. 1920.

10. PINCUS, G., A mosaic (black-brown) coat pattern in the house mouse. *Jour. Exp. Zool.* 52:439-441. 1929.

11. WRIGHT, S., and EATON, O. N., Mutational mosaic color patterns of the guinea pig. *Genetics* 11:335-351. 1926.

TABLE I.—Breeding record of mosaic ♂ 16643 when mated to dilute brown and heterozygous brown females

♀ *No.*		*Color*	*Relation*	*No. Born*	*No. Living*	*dBr*	*Br*
8267		dBr	Mother	5	0		
16644		dBr	Sister	15	13	13	0
16642		dBr	Sister	19	17	17	0
18933		dBr	Daughter	13	13	13	0
18935		dBr	Daughter	6	6	6	0
18936		dBr	Daughter	6	6	6	0
18938		dBr	Daughter	8	5	5	0
Total	×	dBr		72	60	60	0
13312		Br*	No	13	13	7	6
12476		Br*	No	25	22	10	12
Total	×	Br*		38	35	17	18

*Heterozygous.

Shull's *Heredity* Revised

HEREDITY. *by* A. FRANKLIN SHULL, 2nd ed. XV, 345 pp., McGraw-Hill. $3.00.

THE first edition of *Heredity,* by Dr. A. Franklin Shull, fulfilled a very definite need, that of a brief, clear text for beginning classes in Heredity and Eugenics in colleges and universities. The second edition brings the subject up to date and shows several improvements over the first. The addition of material on chromosomes and sex in plants and of problems at the end of each chapter are to be noted particularly among these. Other changes for the better are the expansion of the first chapter on Rise of Knowledge of Here-

dity, the revision of chapters on Immigration, Population Problems, Evolution, and Heredity in Man, the addition of sections on multiple allelomorphs and lethals. The chapters are short and unified; each is illustrated sufficiently and well. The sections on human heredity and eugenics are critical and restrained.

However excellent a text may be, there are always teachers who would alter it. The reviewer has used Dr. Shull's book for five years and in as many different classes. It has been found more satisfactory in teaching these classes, to introduce multiple allelomorphism and sex linkage after monohybrid crosses and before linkage and to postpone a discussion of evidence for location of genes in chromosomes until after the presentation of sex linkage and linkage, an order somewhat different from Dr. Shull's. In addition, the diagram of meiosis which Dr. Shull uses in his Animal Biology is to be preferred for accuracy and completeness to that in the book under discussion. These differences are of minor importance, however, and in no way reduce the value of the book which is, without a doubt, the best available for its purpose.

The use of such a text as this for a course in Eugenics is strongly to be advised. Too often is such a course concerned with the more superficial aspects of that subject while the fundamentals are neglected. No teacher or student using this text will define Mendelism as the 3:1 ratio, the conception which the student gets from the average course in psychology, sociology, and even at times, biology, and it is to be recommended to teachers and students in these related fields.

ANNA R. WHITING.
Pennsylvania College for Women.

Problems of Population

POPULATION PROBLEMS, *by* W. S. THOMPSON, Pp. xi + 462. McGraw-Hill. New York. 1930.

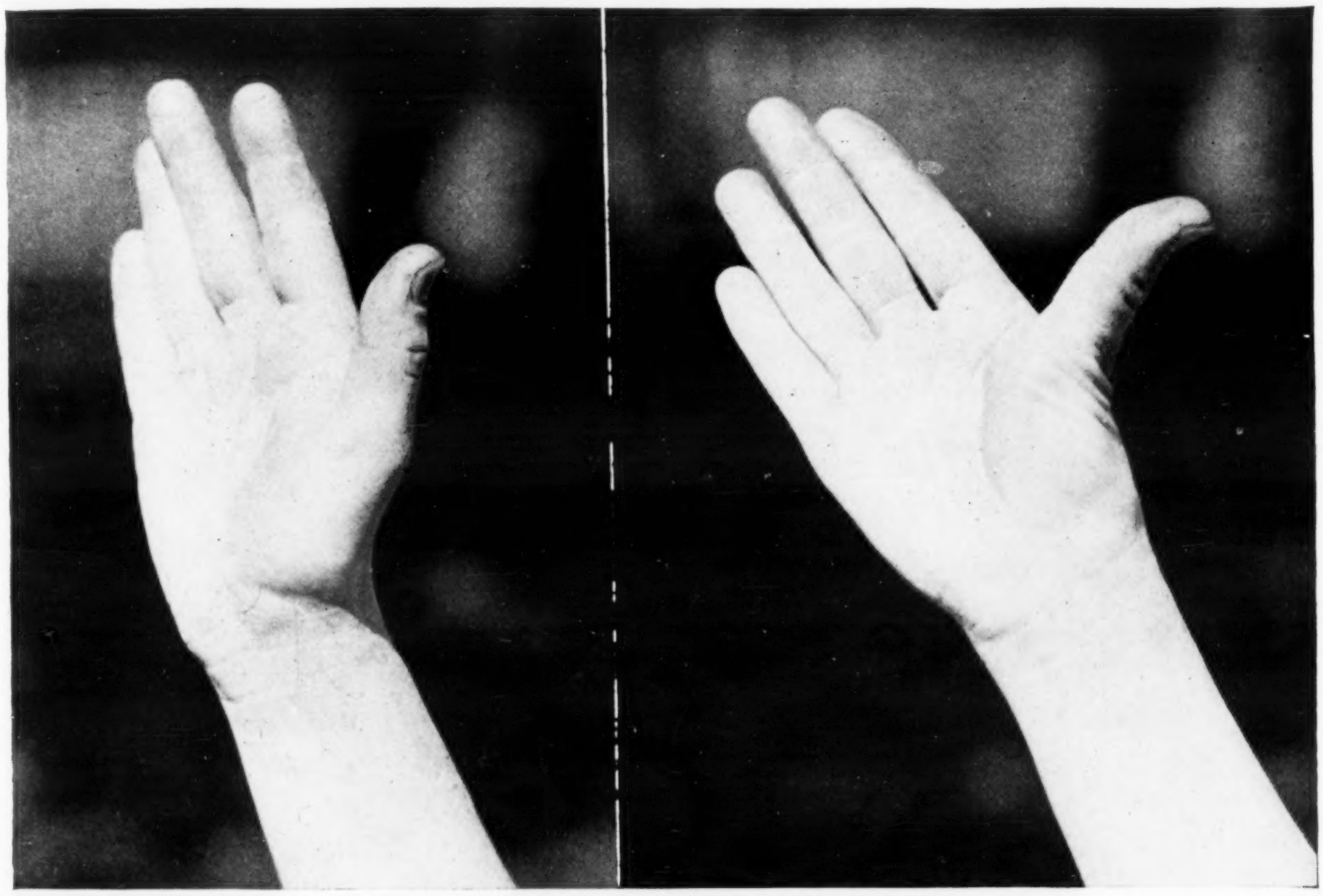
For many years Dr. Thompson has been engaged in a study of problems of population and he has written, besides many articles, three substantial contributions in this field before the publication of the present volume. His *Danger Spots in World Population*, published in 1929, was a timely discussion of questions of importance for human welfare and the peaceful conduct of international affairs. *Population Problems* is a thorough and well documented treatise on the general field, dealing with population from the biological, economic, social and political standpoint. Essentially, Thompson is a follower of Malthus, as we would expect to find in so competent and fairminded a student of the subject. At the same time, he is quite clear as to the errors of detail into which Malthus was betrayed. He is also a Neo-Mathusian, which Malthus was not, because he believes that birth control is a means of averting the various ills with which overpopulation threatens the race. One cannot do justice to so extensive a treatise in a short review. On the whole, Dr. Thompson's volume affords an excellent text and reference book for the student, and there is no expert in the field who would not profit by its perusal.

In his treatment of the rôle of natural selection Thompson expresses a doubt as to whether our advances in civilization have really reduced the rigor of this eliminative process. So far as I am aware, he is the only one besides the reviewer who has expressed this particular view. There is a useful bibliography of 332 titles. If one could possess only one book on population it should be this one.

S. J. HOLMES.

INHERITANCE OF DOUBLEJOINTEDNESS IN THE THUMB

LEON F. WHITNEY
New Haven, Connecticut



A NEW MENDELIAN CHARACTER

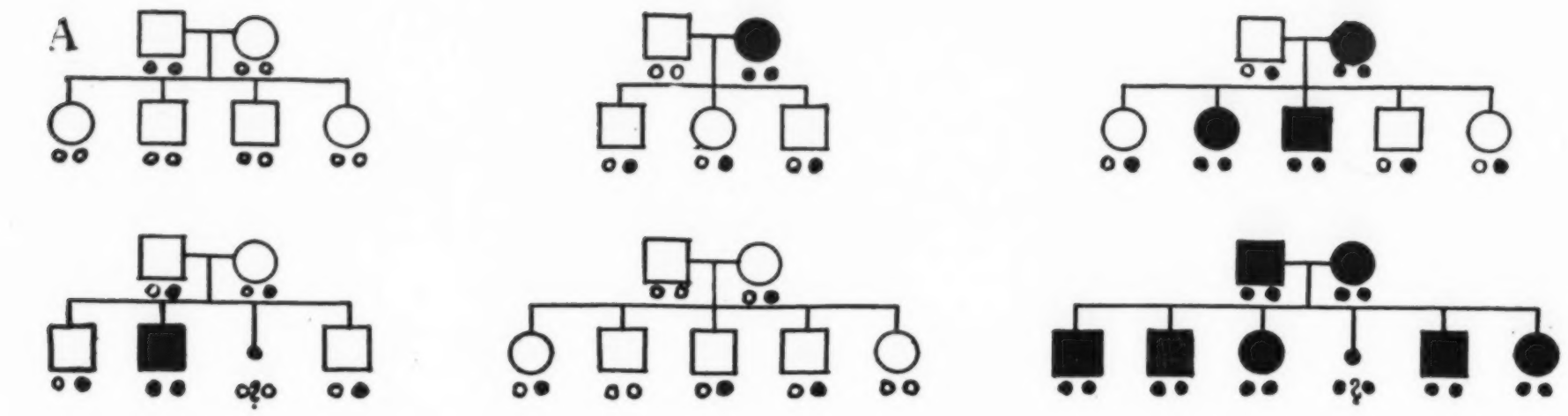
Figure 11

Most people are able to move the thumb only in one direction—inward toward the palm of the hand. A few people are able to bend the thumb outward, as in the photograph at the right. This peculiarity is inherited in some families as a recessive character.

SOME people are double-jointed in the second (basal) joints of their thumbs. The number is not as large as those who can bend their thumbs in only one direction at this joint. In one group, which was requested to raise their hands if they possessed the ability, 5% showed they did. In another group four in forty did, or 10%.

This ability, so far as I can see, will not add to the sum total of individual or group happiness, unless it be to amuse the children of the family. It might be useful in adding an aesthetic touch to the art of "thumbing" for automobile rides, to which it is hoped, even in these depressed times, few readers of the JOURNAL OF HEREDITY have to stoop. But working out the heredity of the trait does add another item to the known list of Mendelian characters. It may occasionally be useful in questions of disputed paternity, and it makes an excellent feature which can be used in the classroom in illustrating Mendelian inheritance.

For several years I have been collecting data on inheritance of this ability. In all this time I have found



INHERITANCE OF DOUBLE JOINTED THUMBS

Figure 12

A—Actual family pedigrees illustrating the six types of Mendelian inheritance. The black squares (males), and the black circles (females), indicate presence of the trait in the individual. The small dots under the squares and circles indicate the probable germinal composition, as judged by the children of these persons. *B*—Pedigree chart of a family clan showing the distribution of the ability to throw the thumb out of joint. These seven pedigree charts are fairly conclusive evidence that this characteristic is inherited in these families as a Mendelian recessive character.

no case where it has behaved as anything other than a typical Mendelian recessive. The only possible exceptions are four cases in which a parent was double-jointed in only one thumb. (All of these four happened to be the left.) In such cases, it was inherited as though the individual possessed the ability in both thumbs.

Of the families questioned, the great majority could not bend the thumbs at the second joints. But there were quite a number in which the trait was present. Taking the records collected, I have studied them to see the inheritance pattern where the grandparents, parents, and children were known. From them I find all six possible Mendelian combinations. These are presented as actual pedigrees with the theoretical germinal composition, judging from the children these persons have produced. The germinal composition is thus represented by the little circles under the larger circles or squares.

The black circles and squares represent the presence of the trait, the white the absence. A black circle or square therefore, means a homozygous recessive, whereas a white circle or square may mean either a homozygous dominant or a heterozygous individual.

The larger pedigree represents an actual family clan showing the distribution in a case where it is fairly prevalent—much more so than one ordinarily finds. This happens to be my own family group, on the maternal side.

I am at present collecting data on the inheritance of the ability to bend the thumb backward at the first joint. This characteristic also runs in families, and it is interesting that it is inherited independently of the double-jointedness in the second joint. As soon as I have sufficient data, I will present another paper which will show its inheritance pattern and how the two are inherited in families, in an independent manner.

FERTILE GOURD-PUMPKIN HYBRIDS

The Inheritance of Factors for Shape and Color in Summer Squash-Gourd-Pumpkin Crosses of *Cucurbita pepo*

THOMAS W. WHITAKER

Miller School of Biology and the Blandy Experimental Farm, University of Virginia

THE problem of inheritance of fruit shape and color in *C. pepo*, owing to the striking diversity of the material, has attracted many plant hybridizers. The most pertinent work on this subject has been done by Sinnott and his co-workers. In a series of papers (1922-31), they have reported the isolation of several factors for shape. The general conclusion they have reached is that each particular fruit shape is the result of a balance of factors, each factor producing a slightly different expression.

Regarding the inheritance of fruit color, Sinnott and Durham[4] have shown that in the body color of the fruit, white is dominant over yellow and yellow over green. It is stated that there may be two independent factors for white. There are apparently various modifying colors entering, which complicate the genetic analysis.

The present work has resulted from an attempt to secure hybrid fruit between the common summer squash and pumpkin types of *C. pepo* and the yellow flowered gourds (*C. pepo* var. *ovifera*). The purpose of these hybridization experiments was definitely to establish whether or not all of the various forms of *C. pepo* were cross fertile. The work reported below resulted from attempts to answer this question.

Observations

The seed was secured from commercial sources. The plants used as parent stock have been inbred for four years. During this interval no radical departures in the original fruit shape have segregated, so it can be safely stated that the parent plants were fairly homozygous for the characters involved.

Cross I

A gourd having a characteristic pear shape (Figure 13, *B* and *D*) was crossed with a summer squash of the white scallop type (Figure 13, *A* and *C*). This cross can be made reciprocally with little difficulty. The fruits resulting from a cross of this kind have a large number of well developed, viable seed.

Description of parents.—The gourd parent was typical of its kind, having small yellow flowers, with a strong running type of vine. It is extremely prolific and has dark green pear shaped fruits. The scallop parent was a selection from the Long Island Bush variety. It characteristically has the bush growth habit, with solid white, rather deeply scalloped fruits.

Table I gives a summary of the results from this cross.

This gives a close approximation to a 3:1 ratio, as a comparison of the expected and observed results show. From

TABLE I.—Segregation in Gourd-Squash Hybrids

Parents	*F*1	*F*2	
		Scallop	Pear shape
Scallop × Pear shape	Scallop	36	15
Pear shape × Scallop	Scallop	40	19
	Observed	76	34
	Expected	82.5	27.5

this it is evident that the pear shape of the yellow flowered gourd is recessive to scallop, and is dependent apparently upon a single factor difference.

Cross II

One of the nest egg gourds (*C. pepo* var. *ovifera*) was crossed with a field pumpkin (*C. pepo* var. Mammoth Tours). This cross resulted in several fruits, some of which contained viable seed. The nest egg gourd has a diameter averaging around two inches, and is oval in shape, with solid white body color. The Mammoth Tours pumpkin is one of the largest types of field pumpkins. It has large stems, flowers, and leaves, with a very large solid green colored fruit.

In this cross the writer was more particularly concerned with the inheritance of color. This is one of the few combinations in which the solid body colorings can be studied without complications by striping, variegation, etc.

The results of this cross are summarized below in Table II. From the data it is evident that the solid body color green is recessive to white and its inheritance can be attributed to a single factor difference.

Discussion

It seems that the pear shape of the gourd can reasonably be interpreted as being due to a single recessive factor. This interpretation is not directly in line with that of Sinnott and Hammond[6]. They have analyzed the inheritance of shape in a number of lines and their results have led them to the following conclusion: "A specific fruit shape seems to be the resultant of a balance between a series of factors differing in the degree and direction of their effect. Shapes which are phenotypically identical may be very diverse genotypically." However, in the light of the results of the above experiments there is no alternative except to interpret the difference in shape as simply due to a single factor. A comparable case has been described by Sinnott and Durham[4] in a cross between disc and sphere shapes. The disc shape was completely dominant to sphere. The F_2 generation gave a 3:1 ratio, thus indicating these shapes differed by but a single factor.

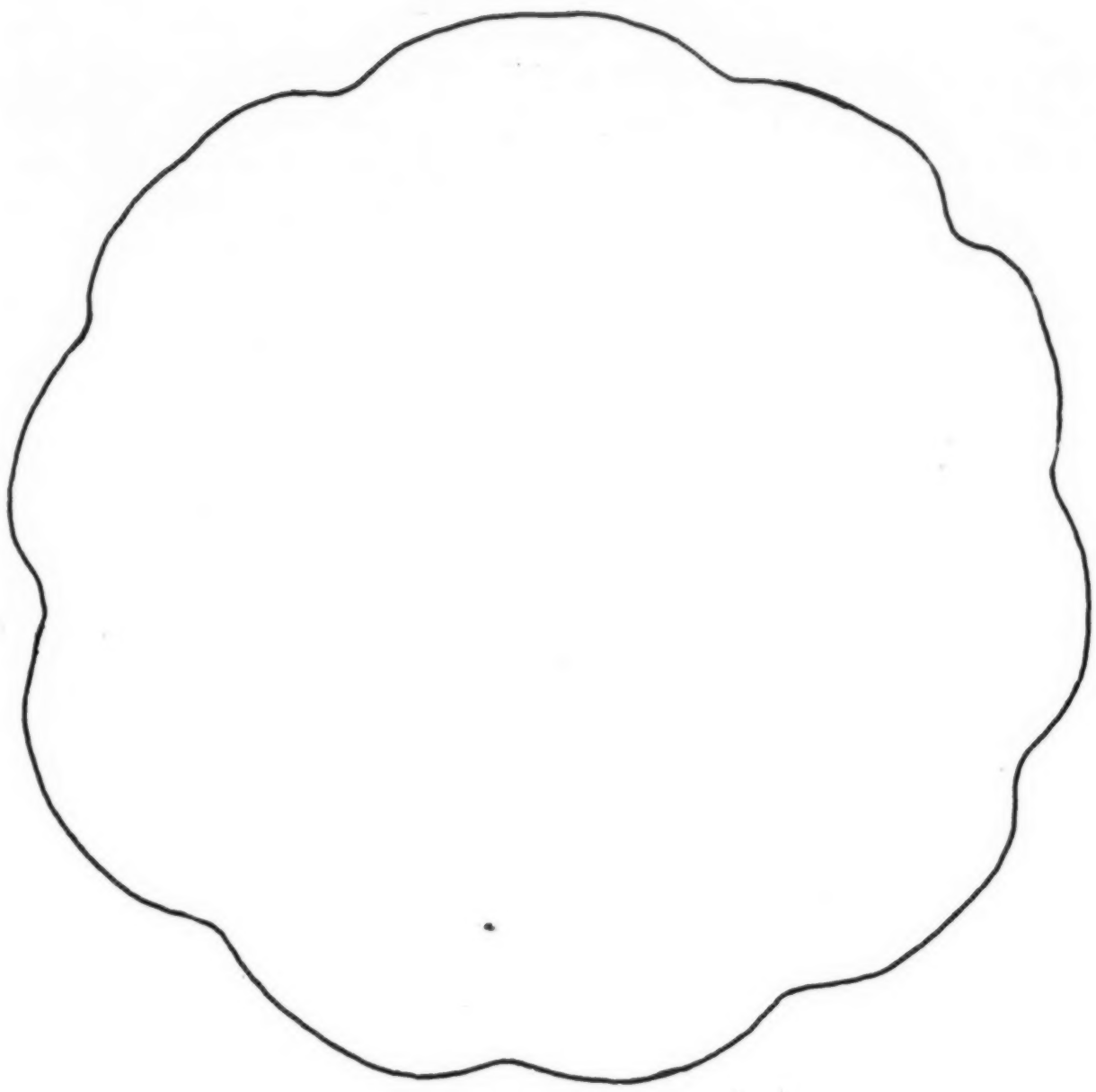
There are other shapes in *C. pepo* which appear to be very complicated and inherited in a manner very difficult of analysis. The cases in which the inheritance of shape is as simple as that described above are very limited. Commercial seed, as a rule, is extremely heterozygous. When a variety is planted it very often segregates into three or four different classes as far as their shapes are concerned. Consequently material of this type is valueless in genetic experimentation until comparatively true breeding stocks have been secured by continuous inbreeding.

In body color of fruit, there are three basic colors, white, yellow, and green. Combinations of these three form a whole series of colors. The inheritance of these seems to be very complex. Environmental conditions, such as nutrition, drought, light, etc., influence these three basic colors and affect the color scheme profoundly. With these various factors at work there appears a whole range of color variation.

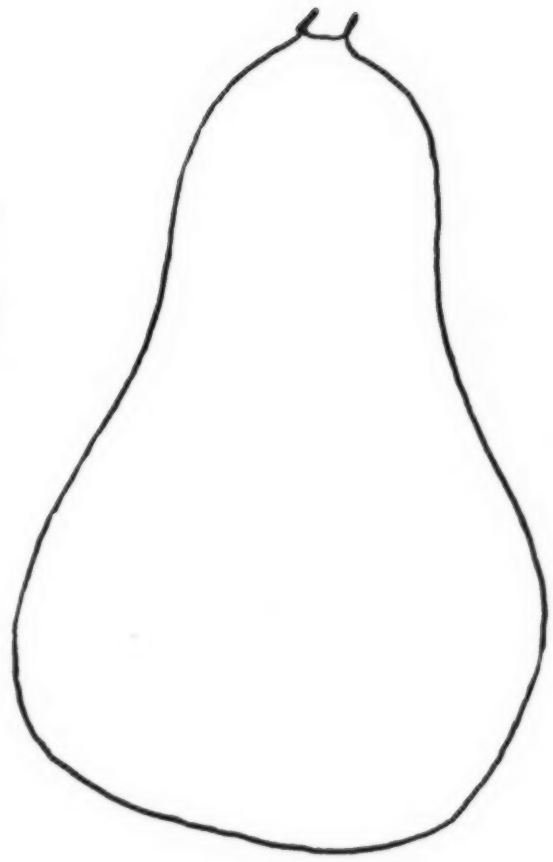
In the particular case chosen for this study, the parent stock (Mammoth

TABLE II.—Color Segregation in Gourd-Pumpkin Crosses

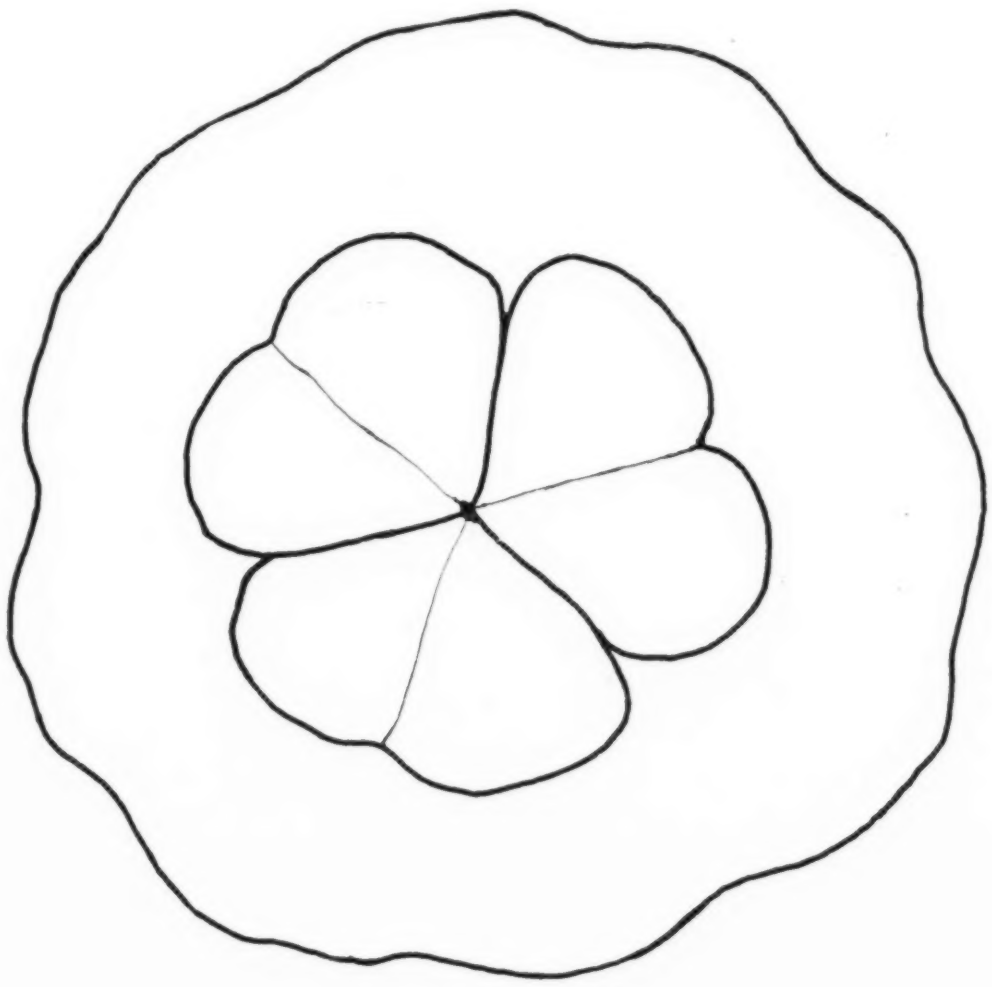
Parents	*F1*	*F2*	
		Nest Egg (white)	Pumpkin (green)
Pumpkin (green) × Nest Egg (white)	Nest Egg (white)	35	17
Nest Egg (white) × Pumpkin (green)	Nest Egg (white)	36	13
	Observed	71	30
	Expected	75.75	25.25



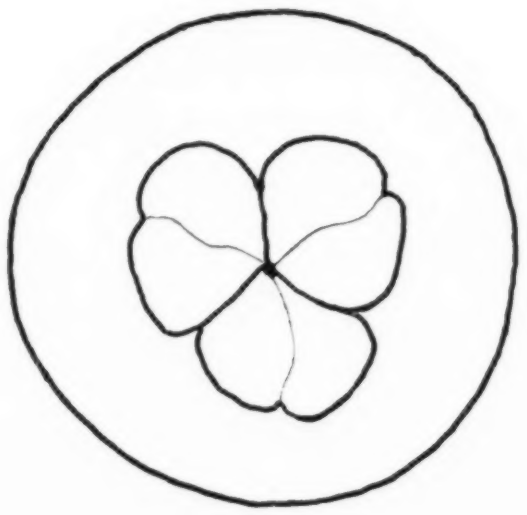
A



B



C



D

SIZE DIFFERENCES IN SQUASH-GOURD HYBRIDS

Figure 13

The parents of the reciprocal cross of a scallop type of summer squash (*A-C*) and a gourd having green pear shaped fruit (*B-D*) was made without difficulty. The F_1 fruits were all scalloped. In the F_2 generation there was typical monohybrid segregation for fruit shape.

Tours) possessed a light green colored fruit. In F_2 the green segregates ranged from very light green to a dark green closely approaching black. An explanation of this situation obviously lies in an investigation of true breeding strains of the greens.

Summary

1. It has been definitely proved that the yellow flowered gourds (*C. pepo* var. *ovifera*) and the summer squash and pumpkin types of *C. pepo* are cross fertile.

2. The pear shape of the gourd is a simple Mendelian recessive to the scallop shape of the summer squash.

3. The green body color of the pumpkin is recessive to the white body color of the nest egg gourd and differs from it by a single major factor.

Literature Cited

1. Bailey, L. H., The domesticated cucurbitas. Gentes Herbarium, 4. 1929.

2. Sinnott, Edmund W., Inheritance of fruit shapes in *Curcurbita pepo*. I. *Bot. Gaz.* 74:95-103. 1922.

3. ————, A factorial analysis of certain shape characters in squash fruits. *Am. Nat.* 61:334-344. 1927.

4. ————, and George B. Durham, Inheritance in the summer squash. *Jour. Heredity* 13:177-186. 1922.

5. ————, and George B. Durham, Developmental history of the fruit in lines of *Cucurbita pepo* differing in fruit shape. *Bot. Gaz.* 87:411-419. 1927.

6. ————, and Dorothy Hammond, Factorial balance in the determination of fruit shape in *Curcurbita*. *Am. Nat.* 64:509-524. 1930.

Sex-Linked Factors Governing Milk Production

A study of the progeny of 728 bulls of the Red Danish breed reported by Dr. Karl Madsen in *Nature* (London), Jan. 30, 1932, suggests strongly that some of the factors governing milk production are sex-linked in their inheritance. The study is based on the fact that a male cannot have sex-linked characters transmitted to him by his paternal grandam. The correlation between the producing ability of the bull's maternal grandam and the bulls' transmitting ability (0.112) was five times as large as the correlation between the bull's paternal grandam and his transmitting ability (0.026). If sex-linkage were not a factor the correlations would be expected to be the same. In a character like milk secretion, which is transmitted by the male but not expressed, such indirect methods are practically the only way that sex-linkage can be demonstrated. Whether Madsen's data are conclusive evidence of the existence of such factors is perhaps open to question.

SUBSCRIPTION BLANK

The American Genetic Association, Victor Building, Washington, D. C.

Gentlemen: I enclose $3.50 (Foreign $4.00) for one year's subscription to the Journal of Heredity.

Name _____

Street and Number _____

City and State _____